Central Alaska Network
Geologic Resources Evaluation Scoping Meeting Summary

A geologic resources evaluation (GRE) scoping meeting was held from February 24 through 26, 2004 at the NPS regional office in Anchorage, Alaska to discuss geologic mapping in and around the parks and geologic resources management issues and concerns. The scoping meeting covered the three parks in the Central Alaska Network (CAKN) – Wrangell-St. Elias National Park and Preserve (WRST), Denali National Park and Preserve (DENA), and Yukon Charley Rivers National Preserve (YUCH). A summary of the status of geologic mapping and resource management issues is presented separately for each of these parks. The scoping summary is supplemented with additional geologic information from park planning documents, websites and NPS Geologic Resources Division documents.

Purpose of the Geologic Resources Evaluation Program

Geologic resources serve as the foundation of the park ecosystems and yield important information needed for park decision making. The National Park Service Natural Resource Challenge, an action plan to advance the management and protection of park resources, has focused efforts to inventory the natural resources of parks. The geologic component is carried out by the Geologic Resource Evaluation (GRE) Program administered by the NPS Geologic Resource Division. The goal of the GRE Program is to provide each of the identified 274 "Natural Area" parks with a digital geologic map, a geologic evaluation report, and a geologic bibliography. Each product is a tool to support the stewardship of park resources and each is designed to be user friendly to non-geoscientists.

The GRE teams hold scoping meetings at parks to review available data on the geology of a particular park and to discuss the geologic issues in the park. Park staff are afforded the opportunity to meet with the experts on the geology of their park. Scoping meetings are usually held in each park individually to expedite the process although some scoping meetings are multipark meetings for an entire Vital Signs Monitoring Network.

Geologic Mapping Overview

With regards to geologic mapping, there are available resources produced at scales that apply to the entire CAKN, and there are also resources specific to the individual parks. Network-wide, the USGS has published OF-133-a *(Wilson, F.H., Dover, J.H., Bradley, D.C., Weber, F.R., Bundtzen, T.K., and Haeussler, P.J., 1998, Geologic map of central (interior) Alaska, U.S. Geological Survey, Open-File Report OF-98-133, 1:500000 scale*), which contains digital geologic maps for many of the 1x2 degree sheets that comprise each park's quadrangles of interest (for DENA 6 of 6 are covered; for WRST 2 of 9, and for YUCH 2 of 4). The USGS has also published Alaska Resource Data Files (ARDF's) for all 1x2 degree sheets in the CAKN with the exception of the Mount Saint Elias sheet, as it has no known mineral potential at this time. USGS 1x2 degree topographic sheets from 1957 have excellent baseline data regarding glacial extent and should be digitized to enhance a CAKN digital geologic database. Finally, an "Exploratory Soil Survey" exists for the entire state of Alaska from the NRCS (National Resource Conservation Service), and could be useful for a digital surficial geologic layer.

The CAKN parks want to make sure that all existing large-scale published and unpublished data were becoming incorporated into existing USGS efforts to map the CAKN; NPS staff will need to work with the USGS compilers to discern original source materials being used to compile these newer maps to make sure the desired maps have indeed been incorporated to produce the best product.

For DENA, the park contains recent, published, digital coverage at least at the 1:250,000 scale from USGS OF-98-133-a for all full 1x2 degree sheet quadrangles of interest that are covering the park (Fairbanks, Kantishna River, Healy, Mount McKinley, Talkeetna Mountains and Talkeetna). This data needs to be converted into a more "NPS-user friendly" version for maximum utility. USGS and NPS-GRE staff will need to work together to accomplish this. The ADDGS has some newer mapping whose release post dates OF-98-133-a, so it is not sure to what degree their work in the Petersville and Chulitna areas has been incorporated.

For WRST, the USGS has a recent (but yet unpublished) compiled, digital geologic map of all of the 1x2 degree sheets for the full quadrangles of interest (there are 9; Nabesna, Gulkana, McCarthy, Valdez, Mount Saint Elias, Bering Glacier, Cordova, Yakutat, and Icy Bay; remember also that both the Nabesna and Gulkana are already published in USGS OF-98-133-a as well). This data has not been officially released, but NPS staff have seen copies and are confident that it will have much utility to the NPS once it has also been converted into an "NPS-user friendly" format. NPS staff anxiously await the publication of this compilation product.

For YUCH, the USGS has published 1x2 degree sheets for two of the four quadrangles of interest (Circle and Big Delta) as part of OF-98-133-a. However, only small portions of the park are covered on these sheets. The other two sheets (Charley River and Eagle) do have published "paper" full sheets by the USGS that are currently being digitized as well as being upgraded as it was noted that their was much disagreement in map units between these quadrangles. Both the ADGGS and USGS have also published recent, digital large-scale maps in the Kandik area, Charley b-1, c-1 and d-1, and Big Delta b-2 quadrangles that should be incorporated into a master digital geologic database.

For the CAKN NPS areas, currently there is considerable published and unpublished geologic map coverage of variable vintage, scale, and authorship; some has been digitized as well. The USGS has produced much digital data for DENA, WRST and YUCH within the last ten years; also recently, areas of DENA and YUCH have had attention from the Alaska Division of Oil and Gas. During the GRE scoping sessions of February 2004, it was a goal to learn about the various geologic mapping efforts and how to synthesize these efforts to produce compiled digital geologic databases for each park. The following attempts to summarize the status of the CAKN for digital geologic maps

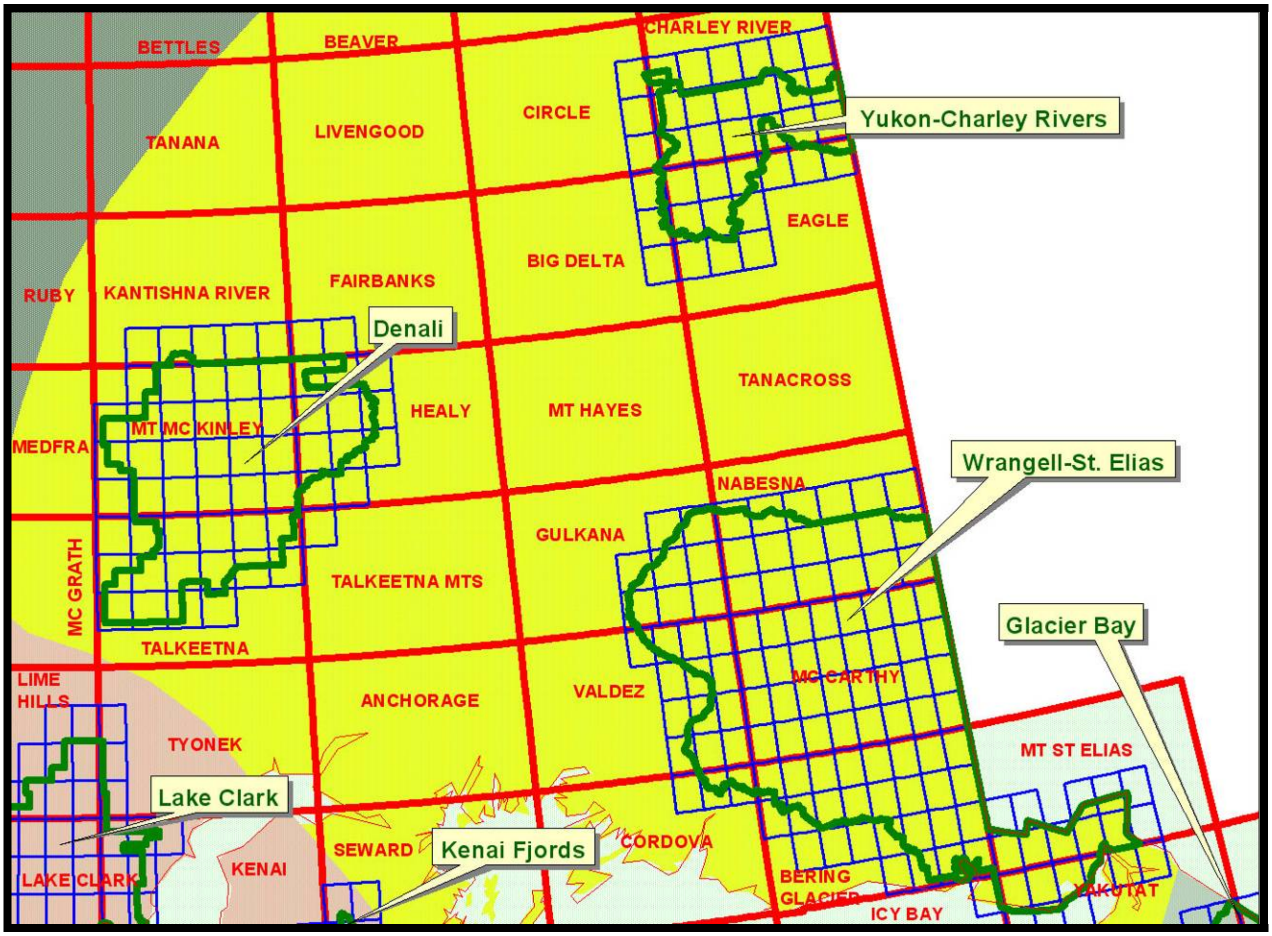

Figure 1. Map Showing NPS-CAKN units (dark green), networks (CAKN: yellow), 1x2 degree sheets (red outline) and 63,360 quadrangles of interest (blue outline)

The USGS has published the Geologic Map of Central (interior) Alaska (full citation: Wilson, F.H., Dover, J.H., Bradley, D.C., Weber, F.R., Bundtzen, T.K., and Haeussler, P.J., 1998, Geologic map of central (interior) Alaska, U.S. Geological Survey, Open-File Report OF-98-133, 1:250,000 scale) as both a paper and digital product. The scale of this mapping is no smaller than 1:250,000 scale, and some portions may have been mapped at a scale larger than 1:250,000. There is also accompanying FGDC (Federal Geographic Data Committee)-compliant metadata. Ric Wilson (USGS) noted that there are now 26 pages of errata to accompany this report that should still be obtained by the NPS. There is also an accompanying FileMaker Pro database with much more attribute and ancillary information that can be massaged to work with, and enhance the utility of the GIS layers.

The OF-98-133-a digital files have been obtained by GRE staff and can be converted into the NPS digital geologic map model with some effort. Tim Connors will need to work with Ric Wilson on the proper linking of data fields and the database relationships to make it work in the NPS-GRE model the way the USGS intended the data to be attributed. Also, Ric Wilson mentioned that the USGS is interested in releasing a “new and improved” version of this map, but no timeframe was given.

All three parks in CAKN have some portions of their 1x2 degree quadrangles (1:250,000 scale) of interest covered in this digital compilation as follows:

- **DENA** completely covered: 6 of 6 1x2 sheets (Fairbanks, Kantishna River, Healy, Mount McKinley, Talkeetna Mountains, and Talkeetna;
- **WRST** only partially covered: 2 of 9 1x2 sheets (Gulkana and Valdez);
- **YUCH** only partially covered: 2 of 4 1x2 sheets (Circle and Big Delta).

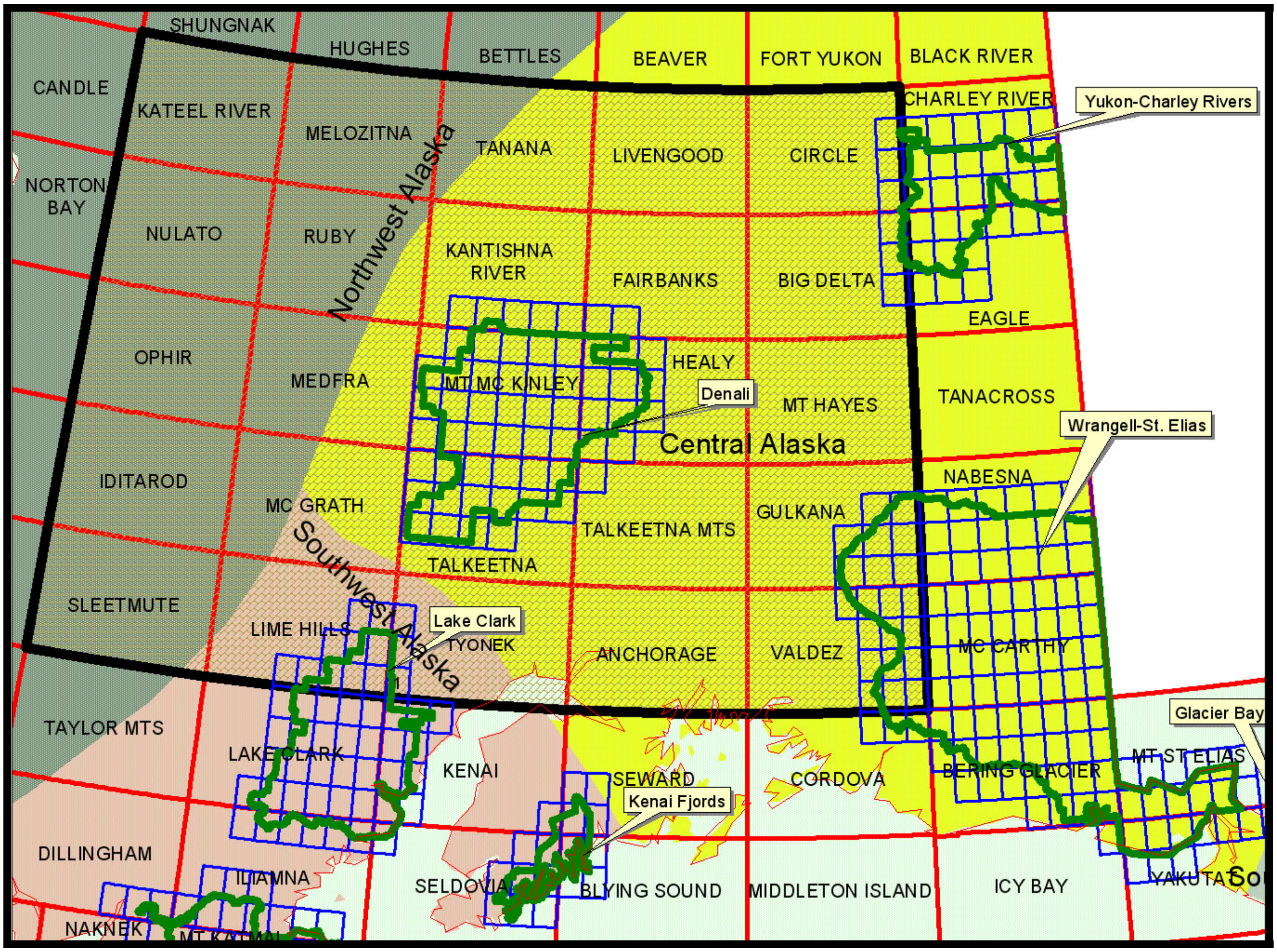

*Figure **2**. Extent of USGS OF-133-a (shown in heavy black outline and slanted brick-like fill) and relation to existing CAKN quadrangles of interest*

Another small-scale dataset of utility to CAKN are the Alaska Resource Data Files. According to the USGS website (http://ardf.wr.usgs.gov/) , there are completed ARDF files for all of the 1x2 degree sheets that encompass the CAKN quadrangles of interest with the exception of Mount Saint Elias, as apparently it has no known mineral occurrences at the present time.

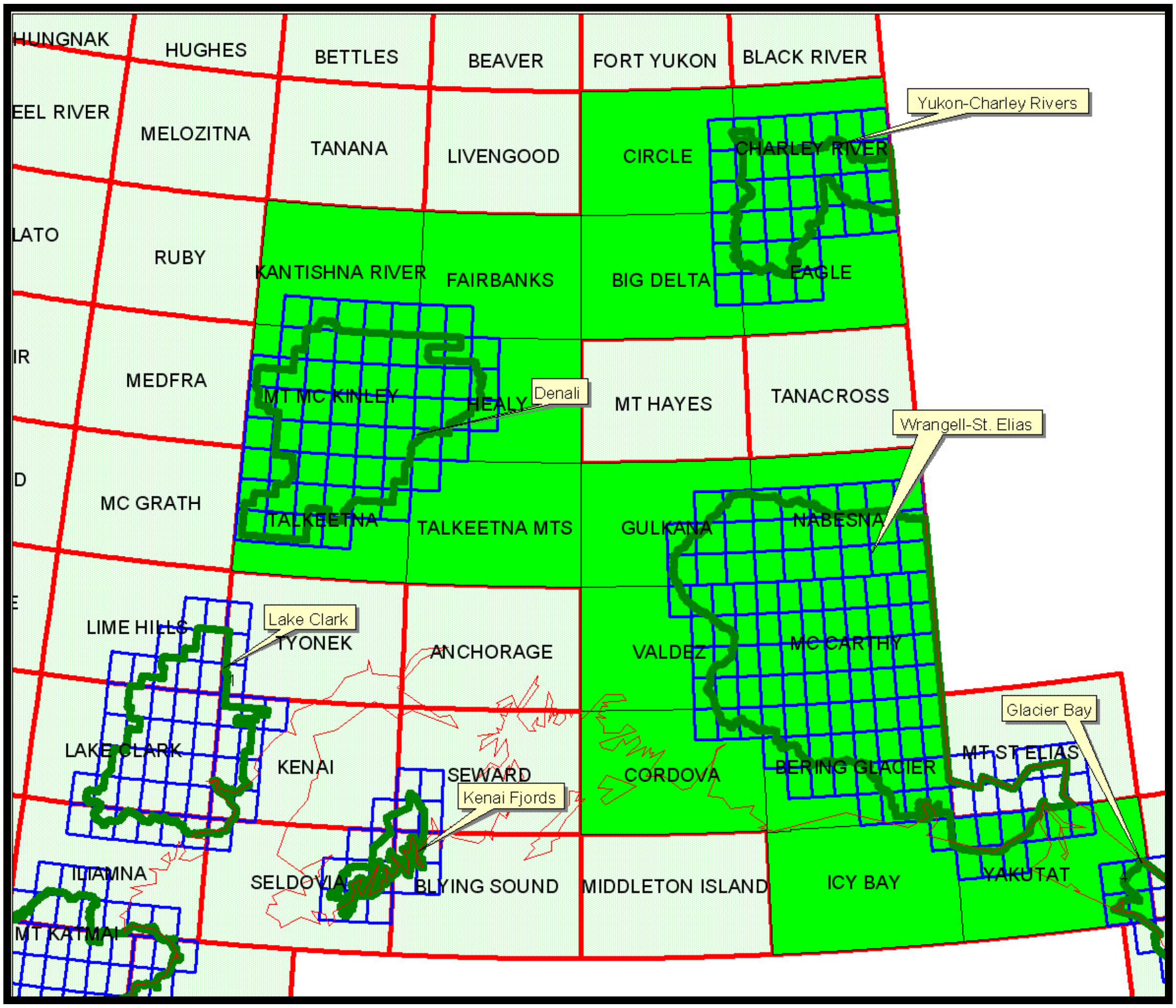

Figure 3. Existing ARDF files (bright green) for CAKN NPS areas. NOTE: Mount Saint Elias is the only 1x2 sheet that is not covered and that is because there are "no known mineral occurrences" at this time.

The USGS classifies these reports as follows: "Descriptions of mines, prospects, and mineral occurrences in the **Alaska Resource Data File (ARDF)** are published for individual U.S. Geological Survey 1:250,000-scale quadrangles in Alaska as USGS Open File Reports and are available for downloading from this site.
These descriptions are divided into fields which describe each mine, prospect, or mineral occurrence. The records in the database are generally for metallic mineral commodities only but also may include certain high value industrial minerals such as barite and rare earth elements. Common industrial minerals such as sand and gravel, crushed stone, and limestone and energy minerals such as peat, coal, oil and gas are not included in this database.

An explanation of the fields used in the database and ARDF reports for individual quadrangles can be viewed or downloaded from this site using software or browsers capable of reading files in the Portable Document Format (PDF) The descriptions in the database were compiled using published literature, unpublished reports and data from various sources including the U.S. Bureau of Mines, the U.S. Geological Survey, and industry. Compilation of this database is an ongoing process and each report is a progress report.

These datasets essentially contain point data of mineral locations and would be very useful in each park's geologic digital database. Some of the fields captured include:

- site name;
- site type;
- a unique location number;
- latitude and longitude coordinates,
- location description and accuracy,
- commodities present,
- ore minerals,
- gangue minerals,
- a geologic description,
- alteration,
- age of mineralization,
- deposit model and number,
- production status,
- site status,
- workings/exploration;
- production notes;
- reserves;
- additional comments;
- references;
- reporter; and
- last date of reporting.

NEED MORE ON AMRAP…
The ALASKA MINERAL RESOURCE APPRAISAL PROGRAM (AMRAP) ______- AMRAP Alaska Mineral Resource Assessment Program digital data (Geochem, geophysics, mineral properties)

Robert Blodgett (paleontologist, USGS contractor) has a comprehensive bibliography of paleontological resources with corresponding coordinates that is available at http://www.alaskafossil.org/ and should be incorporated into a master geologic database for the CAKN parks.

USGS topographic quadrangles (circa 1957; 1:63,360 scale) for the quadrangles of interest of the CAKN parks are of major interest to the parks containing glaciers because it serves as a good baseline for glacial extent and monitoring for today. It was desired to get these maps scanned and digitized for this purpose.

Finally, the NRCS has published an "Exploratory Soil Survey" for the entire state of Alaska, and it is available for download at http://www.ncgc.nrcs.usda.gov/branch/ssb/products/statsgo/index.html ; their website says: "Soil maps for the State Soil Geographic (STATSGO) database are produced by generalizing the detailed soil survey data. The mapping scale for STATSGO is 1:250,000 (with the exception of Alaska, which is 1:1,000,000). The level of mapping is designed to be used for broad planning and management uses covering state, regional, and multi-state areas."

Wrangell-St. Elias National Park and Preserve

Executive Summary

During the Geologic Resources Evaluation scoping meeting, National Park Service, park, and regional staff identified the following geologic digital mapping needs and key resource management issues/needs:

Geologic Mapping:

1. There are recent published digital geologic maps for the Gulkana and Valdez 1x2 degree sheets in USGS Open File 98-133 that are at least 1:250,000 scale in detail. These can be converted into the NPS-GRE model.

2. There is a current USGS (contact Ric Wilson) effort to produce an encompassing digital geologic map of the entire park (it is currently unpublished, with an unknown date of publication) that is at least 1:250,000 scale, with some areas at larger scale where published materials were available to be incorporated. There are numerous map unit attributes that are currently in FileMakerPro format that enhance the quality of the mapping, but these need to be “translated” into the NPS-GRE model for digital geologic maps to maximize the utility of this dataset. NPS-GRE staff will work with the USGS to “translate” the data into a more friendly NPS-user format. Both the Gulkana and Valdez 1x2 degree sheets are included in this effort, and have had updates from what was presented in OF-98-133-a, so the newer versions are more preferable to the NPS.

3. WRST staff want to ensure that all existing published and unpublished larger scale mapping (essentially everything greater than 1:250,000 scale) has been incorporated into this recent USGS WRST compiled digital park map, especially for the “core” areas that the park has identified (Nabesna and McCarthy Road corridors, the highest used areas in the park). Numerous quadrangles were mentioned, and are enumerated in the following sections.

4. Danny Rosenkrans would like to digitally capture glacial boundaries presented on the USGS 1957 1:63,360 scale topographic maps encompassing the WRST quadrangles of interest as a “baseline” for glacier extent. NPS-GRE staff will digitize the features from these maps.

Geologic Resource Management

Published and unpublished geologic information in electronic form (spatial data) (see above),
Glacial extent in 1957, 1983 (see above),
Paleontology – need more information, site locations, and
Development of geologic interpretive materials for the park (6-12 fact sheets).

Introduction

In 1980 Congress passed and President Carter signed the Alaska National Interest Lands Conservation Act (ANILCA). ANILCA, Section 201(9) established Wrangell-Saint Elias National Park and Preserve (WRST), containing over 13 million acres of public lands to be managed for the following purposes, among others:

> *To maintain unimpaired the scenic beauty and quality of high mountain peaks, foothills, glacial systems, lakes and streams, valleys, and coastal landscapes in their natural state; to protect habitat for, and populations of fish and wildlife including but not limited to caribou, brown/grizzly bears, Dall sheep, moose, wolves, trumpeter swans and other waterfowl, and marine mammals; and to provide continued opportunities, including reasonable access for mountain climbing, mountaineering, and other wilderness recreational activities. Subsistence uses by local residents shall be permitted in the park, where such uses are traditional, in accordance with the provisions of title VIII.*

WRST is administered subject to valid existing rights, pursuant to the NPS Organic Act of August 25, 1916 (as amended and supplemented) which established the National Park Service, and other applicable provisions of ANILCA.

Wrangell-St. Elias National Park and Preserve is the nation’s largest national park unit (13.2 million acres), and designated wilderness (9.6 million acres). The park and preserve extend over a region of vast proportions and diverse environments, representing some of the most outstanding examples of Alaskan natural and cultural resources. Extensive high mountain terrain, enormous glaciers and ice-fields, active thermal features, large canyons, extensive wildlife populations, and major historic mining features represent the significance of the park and preserve. Wrangell-St. Elias National Park and Preserve, Kluane National Park in Canada, Glacier Bay National Park and Preserve, and British Columbia’s Tatshenshini-Alsek Park are, together, the world’s largest designated World Heritage Site—an area encompassing 28 million acres.

Geologic Overview

Geologically, the Wrangell-St. Elias National Preserve is significant because it contains:

- the largest assemblage of glaciers and greatest collection of peaks over 16,000 feet in the National Park System. The Nabesna Glacier is the world’s longest interior valley glacier (over 75 miles long), the Malaspina Glacier is North America's largest piedmont glacier (nearly 40 miles across), and the Hubbard Glacier is the longest tidewater glacier in Alaska (over 76 miles long with an open calving face covering over 6 miles),
- Bagley Icefield is the largest, subpolar icefield in North America,
- Chitistone and Nizina Canyons display many of the diverse geological features and processes of eastern Alaska in a relatively small area,
- Wrangell Volcanic Field contains active Mt. Wrangell, one of the largest andesitic volcanoes in the world,
- active thermal features such as mud volcanoes and thermal springs, and
- major historic mining features – Kennecott Copper deposits among others.

The geology of the park/preserve is extremely diverse. Rock formations include those of igneous, sedimentary, and metomorphic origins. Paleontological resources have been found in Permian to Tertiary-aged rocks, but have not been thoroughly inventoried in the park/preserve.

The principal basement rocks in the park/preserve are called the Wrangellia Terrane, part of a group of exotic terranes that accreted to Alaska and the North American continent during the past few hundred million years. On the basis of geophysical and fossil evidence, rocks of the Wrangellia terrane were formed in a tropical environment thousands of miles south of its present position. The Wrangellia terrane began as a volcanic arc about 300 million years ago, most likely along the margin of an ancient North American Continent. As arc-related volcanic activity waned, a rift developed between the arc and continent, allowing the eruption of basaltic lava flows that flooded and filled the rift-formed basin. Subsequently, shallow warm seas inundated the land, depositing layers of marine limestone and other sediment on top of the volcanic rocks. During the next 200 million years, the Wrangellia Terrane was gradually transported northward, where it was welded to other terranes and eventually accreted against western North America about 100 million years ago. It now forms a belt extending from southern Alaska to southern British Columbia. Subsequently, other terranes have been carried northward and accreted to continental Alaska. The last terrane to arrive — the Yakutat terrane — docked about 26 million years ago, concurrent with and partly responsible for the development of the Wrangell volcanic field. (http://gorp.away.com/gorp/resource/us_national_park/ak/geo_wran.htm)

The collision of the terranes resulted in uplift and formation of the massive mountain ranges in the park/preserve. Two major faults run through the park/preserve displaying evidence of major tectonic plate movement resulting in major earthquakes and associated volcanic activity.

The Wrangell Mountains are geologically young volcanoes. Mt. Drum (12,010 feet), Mt. Sanford (16,237 feet), Mt. Blackburn (16,390 feet), and Mt. Bona (16,421 feet) are dormant, but Mt. Wrangell (14,163 feet) is still active with vents of steam near the summit. Mt. Wrangell is one of the largest andesitic volcanoes in the world. It erupted as recently as 1930, and while relatively quiet since then, an abrupt increase in heat flux at the summit occurred following the great Alaska earthquake in 1964 (Benson 1982). Although heat flow has been variable since 1964, it has recently been showing a dramatic increase (Motyka and Benson 1983). The shield volcanoes of the western Wrangell Mountains are different than other volcanoes located around the Pacific Rim. Rather than having explosive eruptions typical of the volcanoes in the Pacific Rim that form steep-sided cones, the Wrangell Mountains have been built by the accumulation of hundreds of relatively fluid lava flows that form broad mountains with gentle slopes.

On the western flank of Mt. Drum are three large thermal springs known as mud volcanoes. The western Wrangells area is being studied for geothermal energy development by the state of Alaska and USGS. It appears to have high geothermal energy potential, given the proximity to the state's road system (USDI, GS 1982).

The eastern Chugach Mountains, Wrangell Mountains, and St. Elias Mountains in the U.S. and Canada include the largest concentration of glaciers in North America. Many of these are in a state of equilibrium or retreat. Some are still steadily advancing, and others are subject to periodic surges. Surging glaciers are of considerable scientific interest. Variegated Glacier has been of particular interest because it surges every 20 years. Malaspina Glacier, the largest piedmont glacier in North America has been placed on the National Registry of Natural Landmarks. It covers an area of about 1,500 square miles, an area larger than the state of Rhode Island. Hubbard Glacier, which flows out of the St. Elias Mountains from Canada into Disenchantment Bay, is one of the largest and most active glaciers in North America. Moving at a rate of approximately 10 meters per day. it has the highest, continuous velocity of any glacier on the continent.

The park also includes large icefields, which supply ice to these glaciers. Bagley Icefield is the largest, subpolar icefield in North America.

Another related phenomenon is the glacier dammed lakes, of which there are many in the park/preserve. These lakes can release, suddenly causing outburst floods on rivers below (Post and Mayo 1971). One such lake, Hidden Creek Lake, releases annually, causing intense flooding on the Kennicott River. Others include Oily Lake and Malaspina Lake.

The Copper River is the major watercourse in the region, forming the western boundary of the park/preserve. Major tributaries from within the park include the Chitina, Kotsina, and Bremner rivers.

All major streams in the park/preserve drain glaciers and consequently transport large amounts of silt during the summer

WRST Geologic Mapping

The existing USGS OF-133-a contains digital geologic mapping for both the Gulkana and Valdez 1x2 degree sheets (1:250,000 scale), and thus 2 of the 9 sheets have already been published and are in a digital format that can be "converted" to the NPS-GRE digital geologic map model

WRST's quadrangles of interest encompass portions of 9 USGS 1x2 degree (1:250,000 scale) quadrangles for the following: Nabesna (partial), Gulkana (partial), McCarthy (whole), Valdez (partial), Mount Saint Elias (partial), Bering Glacier (partial), Cordova (partial), Yakutat (partial) and Icy Bay (sliver). At a larger scale, WRST has (122) 1:63,360 scale quadrangles of interest.

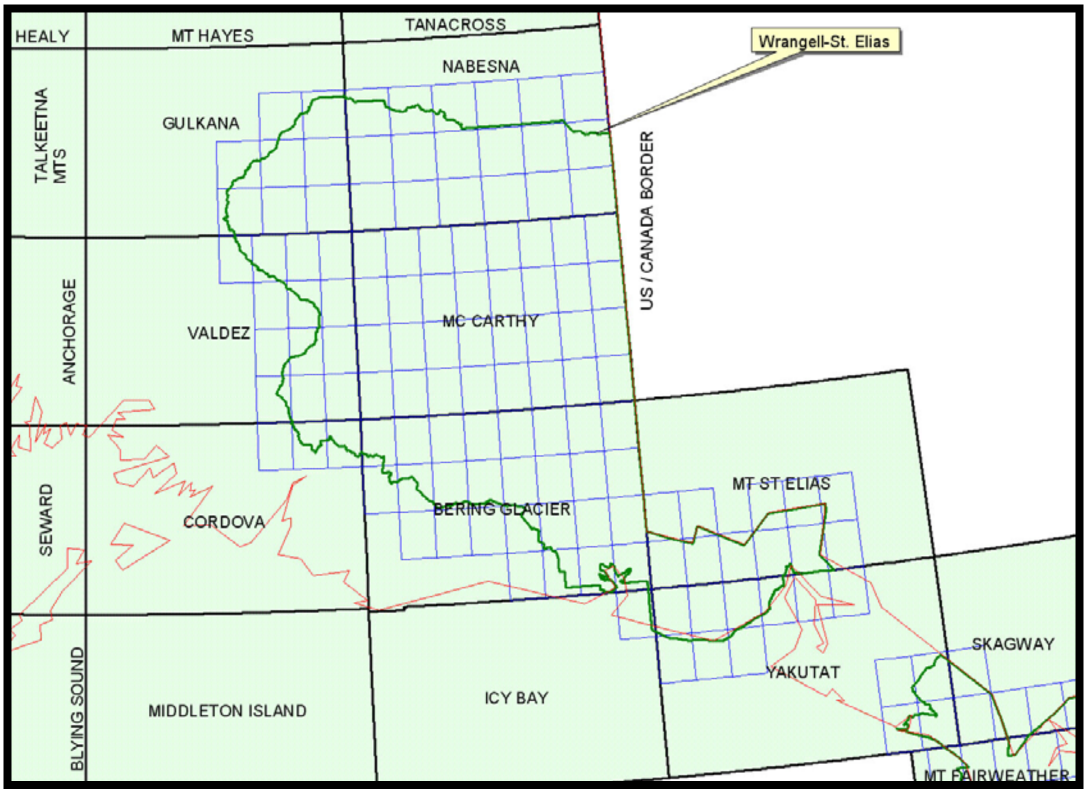

Figure 4. 1 x 2 degree (250,000 scale) sheets for the WRST area shown in black outline and lighter green backfill with name of sheet; 63,360 sheets shown in blue outline without subdividing quadrangle names; WRST boundary in green

At the present time, the USGS is engaged in a significant effort to produce an encompassing, stand-alone digital geologic map of WRST that is at least as great as 1:250,000 scale, with much larger scale mapping included where it was available. This likely includes many of the published larger scale 1:63,360 maps (there were approximately 43 individual 63,360 scale quadrangle maps that have been previously published at varying times, with variable attention to bedrock and surficial units).

This map has not yet been "officially released" and is considered to be "preliminary" and for "in-house" use only. Because of the large area covered and volumes of information in this database, much more NPS-GRE staff time, manpower, and energy needs to be focused on "converting" and "translating" this compilation map to maximize its utility to the NPS and to discern all of the information that has already been captured and attributed as soon as it is "officially" released as a USGS publication (date unknown); GRE staff are excited about obtaining the finalized USGS product and "converting" it into the NPS-GRE model for digital geologic databases.

GRE staff did receive a "preliminary, unreleased" copy of the digital dataset from Danny Rosenkrans (who received his copy from Ric Wilson) and continue to evaluate it at the present time. The following figure shows the detailed extent of the polygons captured by the USGS; again, it just needs to be "translated" from the USGS FileMakerPro format to something readable by the NPS for maximum utility. It is readily apparent that there is considerable detail that has gone into this compiled map by the USGS.

The ADGGS has also published a series of reports on the Copper River Basin (*DGGS Staff, 1985, Resource information - Copper River Basin land-use plan, geologic constraints: Alaska Division of Geological & Geophysical Surveys, Public Data File 85-15, reports A-L, numerous sheets, at least at scale 1:250,000; available on the web at* *http://dggs.dnr.state.ak.us/pubs/pubs?reqtype=series&abbrev=PDF&abbrevID=209&seriesname=Public%20Data%20File*). It is not known how much of this information has been incorporated into the compiled USGS WRST map, but it appears to have much usable information and GRE staff need to evaluate it further. The contents of these reports are as follows:

- PDF 85-15A: geologic constraints, 12 sheets.
- PDF 85-15B: engineering geology, 43 sheets.
- PDF 85-15C: mineral and energy resources, 4 sheets.
- PDF 85-15D: mineral terranes, 4 sheets.
- PDF 85-15E: vegetation, 39 sheets.
- PDF 85-15F: surface hydrology, 4 sheets.
- PDF 85-15G: infrastructure, 16 sheets.
- PDF 85-15H: land use, 4 sheets.
- PDF 85-15I: land ownership, 4 sheets.
- PDF 85-15J: political boundaries and administrative units, 4 sheets.
- PDF 85-15K: interpreted geologic characteristics chart, 1 sheet.
- PDF 85-15L: geologic-literature references, 4 sheets.

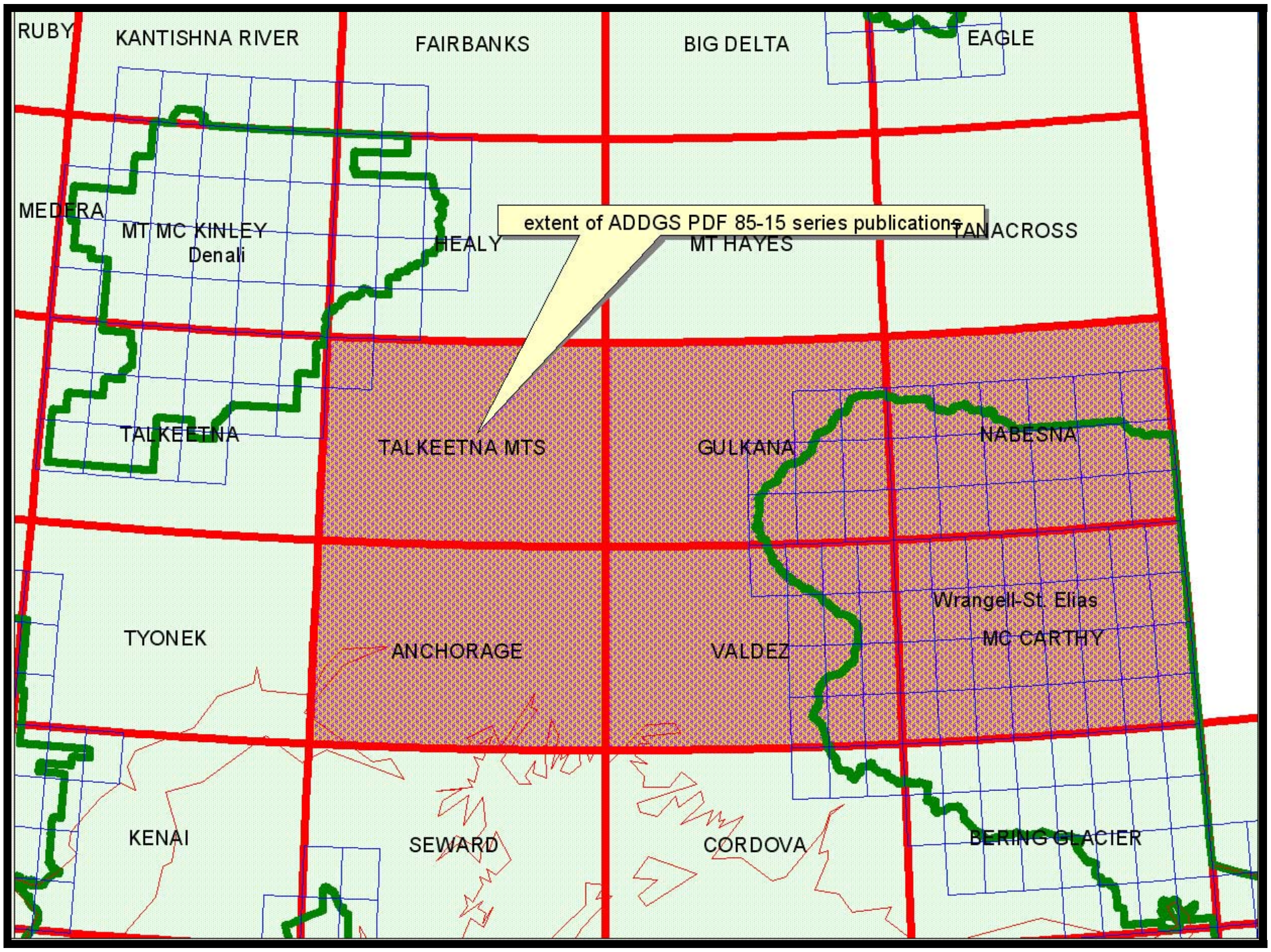

Figure 5. Extent of ADGGS Copper River Basin reports PDF 85-15, A-L

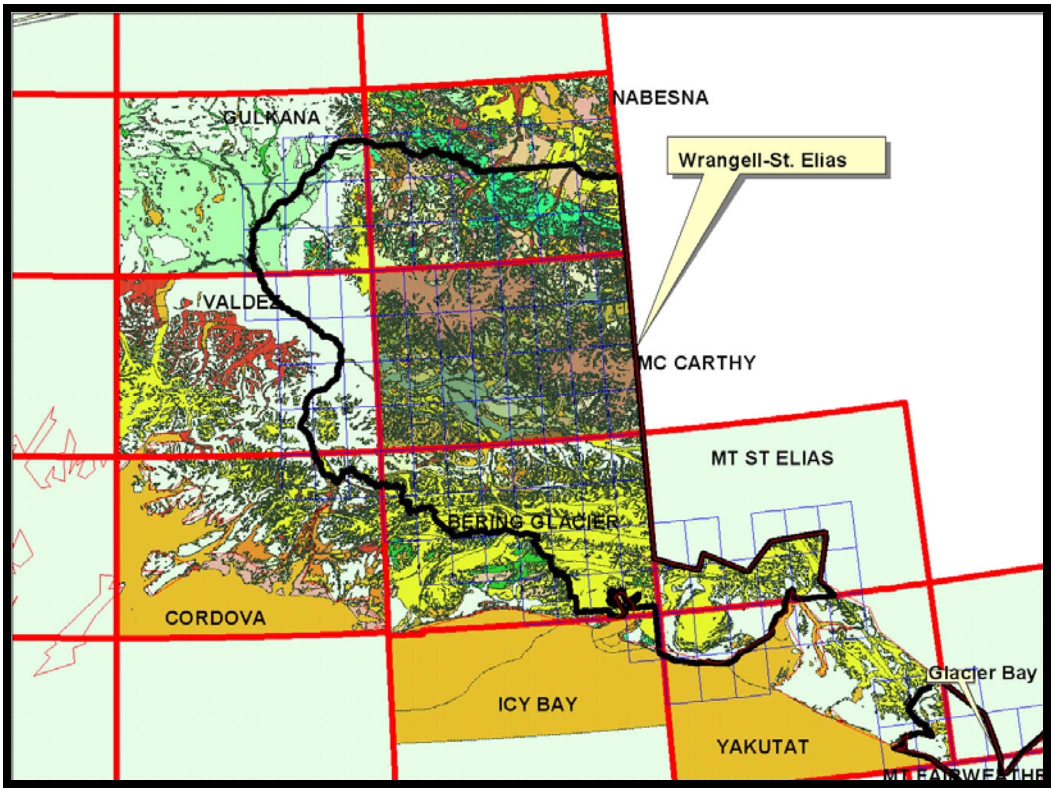

Figure 6. USGS "unpublished" WRST compiled digital geologic map. Polygons broken out by USGS "NSA Class" field. 1:250,000 sheets shown in red outline with name in black capital letters; 1:63,360 sheets shown in blue outline without subdividing quadrangle names; WRST boundary in black.

DESIRED GIS COVERAGE TO INCLUDE:
To reiterate, if it is not already included in the USGS WRST geologic database, WRST staff (Danny Rosenkrans and Devi Sharp) desire the incorporation of some other large scale mapping that they are aware of for WRST. By working with the USGS, it is hoped that the individual source maps that feed into the compiled map will be easily discerned and it will be known if the desired maps of WRST staff have already been included in the compiled map. These specific items include the following published and unpublished information:

- **Nabesna b-6 quadrangle** (*Richter, D.H., Smith, J.G., Schmoll, H.R., and Smith, R.L., 1993, Geologic map of the Nabesna B-6 quadrangle, South-Central Alaska: U.S. Geological Survey, Geologic Quadrangle Map GQ-1688, scale 1:63360*)

- **McCarthy d-1 quadrangle**; http://pubs.usgs.gov/imap/i-2695/ ; (*Richter, D.H., Ratte, J.C., Leeman, W.P., and Menzies, Martin, 2000, Geologic map of the McCarthy D-1 quadrangle, Alaska: U.S. Geological Survey, Geologic Investigations Series Map I-2695, scale 1:63360*)

- Danny Rosenkrans desires digitizing of all 63,360 USGS topographic maps to get glacial boundaries; check with ENSTAR folks; this is for both DENA and WRST; based upon 1957 topographic sheets only

- *Jones, S.H. and Glass, R.L., 1993, Hydrologic and mass-movement hazards near McCarthy, Wrangell-St. Elias National Park and Preserve, Alaska, U.S. Geological Survey, WRI-93-4078, 1:25000 scale*

- Hank Schmoll's surficial geologic maps of the Valdez d-1, Valdez d-2 (which it is believed the USGS Alaskan Volcano Observatory might have; Danny Rosenkrans will check on this), Gulkana a-3, and Gulkana b-2; and Nabesna c-6

- Large-scale bedrock and surficial mapping in the "core" areas of the Nabesna and McCarthy road corridors:
    - In the Nabesna core area this includes the Nabesna c-4, Nabesna c-5, Nabesna c-6, Nabesna b-4, Nabesna b-5 and Nabesna b-6 quadrangles;
    - In the McCarthy core area this includes the McCarthy c-5, McCarthy c-6, McCarthy c-8, McCarthy b-5, McCarthy b-6, McCarthy b-7, McCarthy b-8, McCarthy a-5, McCarthy a-6, Valdez c-1 and Valdez b-1.
    - NOTE: GRE staff have already digitized Lynn Yehle's unpublished surficial maps of the McCarthy b-6, b-7, b-8, and c-8 quadrangles, but need to complete metadata at this time. Also, there are published large-scale maps for these core areas, except for the Nabesna c-6 quadrangle.

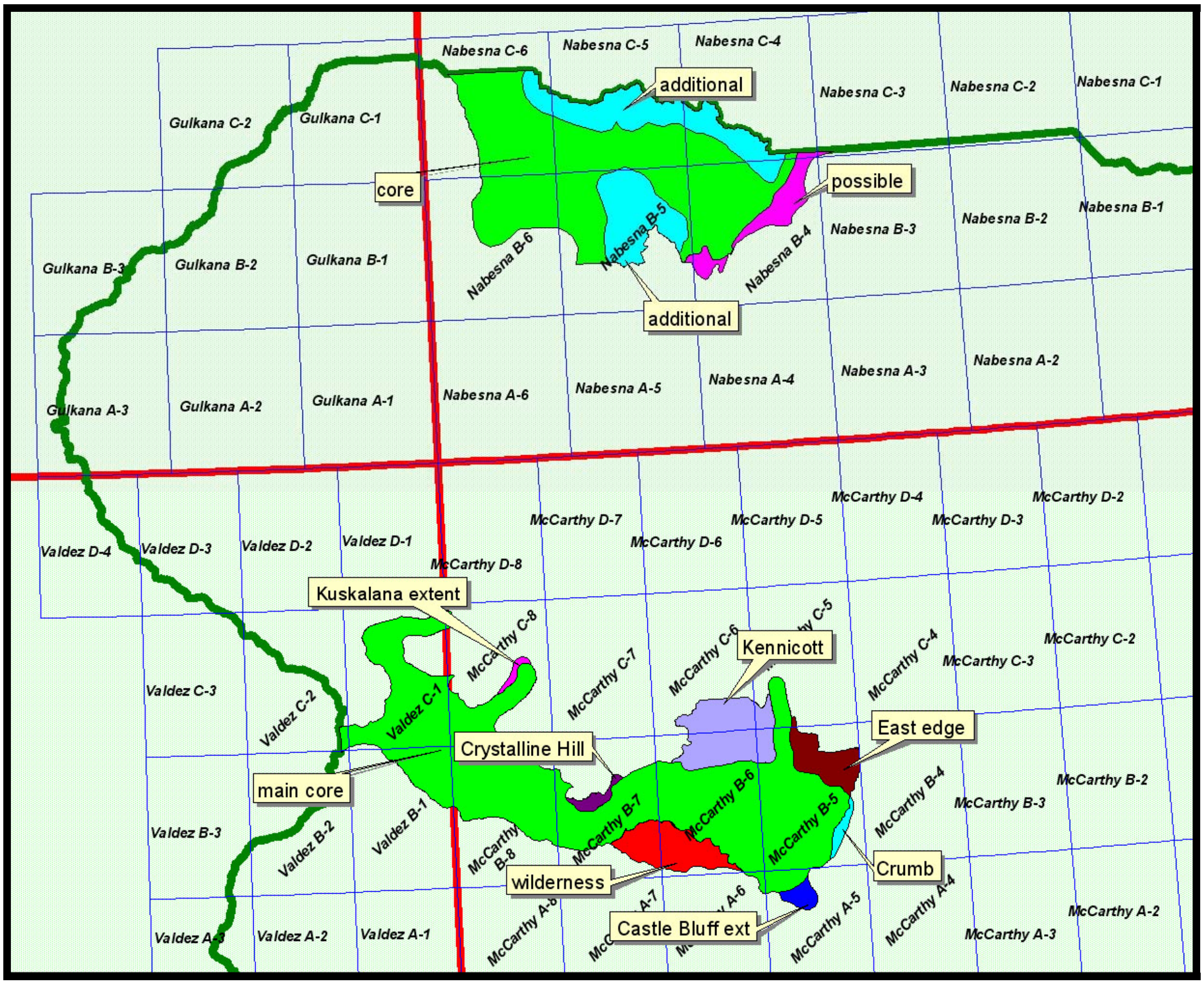

Figure 7: Nabesna and McCarthy "Core" areas and corresponding 63,360 quadrangles (Geology not shown).

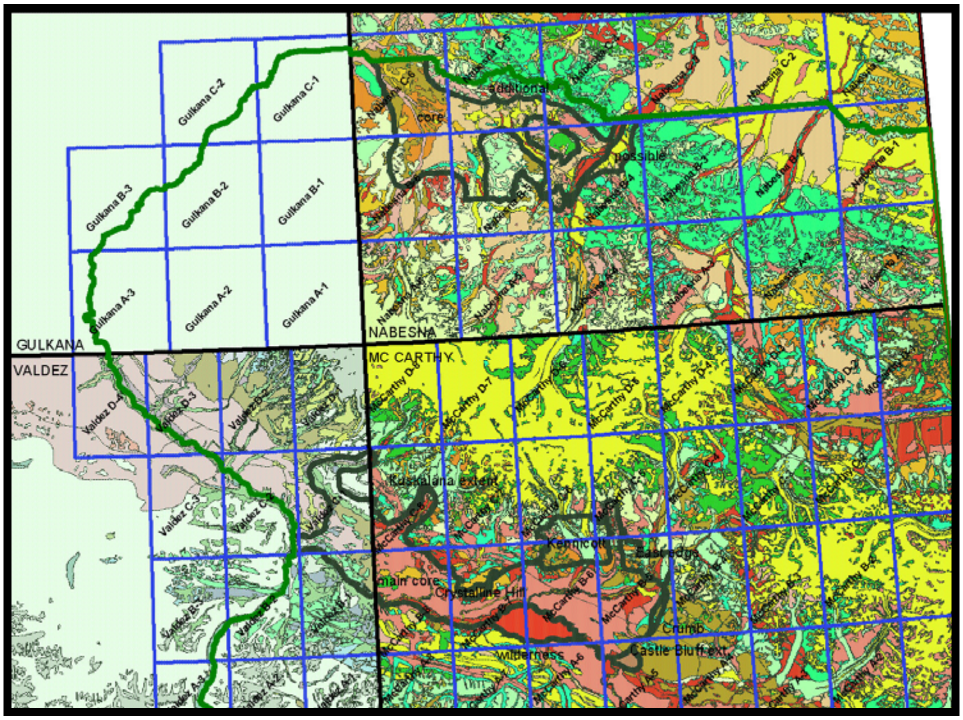

Figure 8. Nabesna and McCarthy "Core" areas and corresponding 63,360 quadrangles (Geology detail shown taken from unpublished USGS 1:250,000 scale maps)

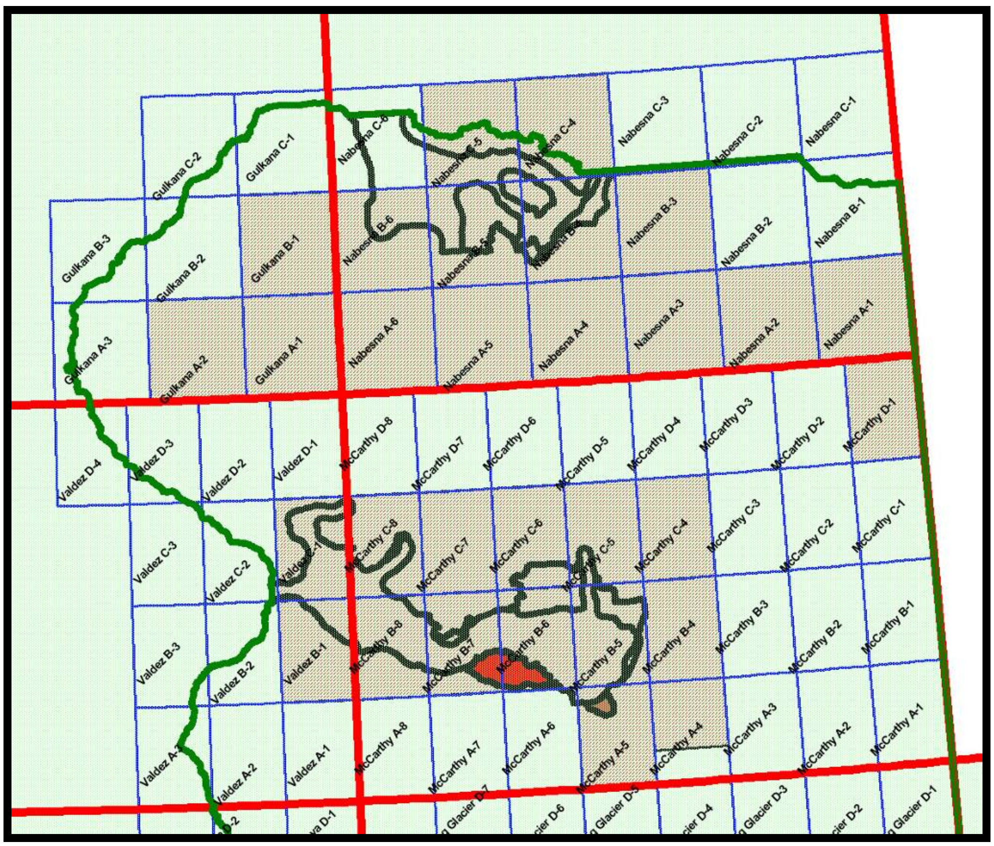

Figure 9. Known large-scale quadrangle mapping (1:63,360 scale) in WRST core areas (both published and unpublished shown in brown); need to discern if these efforts are already incorporated into unpublished USGS 250,000 scale WRST geologic map.

- It was mentioned that there was larger-scale mapping (one inch/mile; 100,000 scale) for the northwest tier of the Bering Glacier 250,000 sheet (the “d” and “c” individual quadrangle areas) by George Plafker; it was not known if these maps had already been incorporated into the recent USGS WRST compilation

Bibliography

The park does not have a park-wide geologic bibliography. It appears that USGS and other sources of data were not found during the bibliographic search.

Add to the bibliography:

- -USGS, A geologic Guide to Wrangell-Saint Elias National Park and Preserve Alaska, USGS P.P. 1616
- -Richter, D., Volcanoes of Wrangell Mountains
- -Mao and Post – mapped landslides, glacial outbursts, and avalanches in park

- -Robert Blodgett (USGS) is developing state-wide Paleontologic bibliography, which can be found at http://www.alaskafossil.org

Geologic Features and Processes

The discussion of geologic features and processes was prioritized by the meeting participants. The prioritized list presented below reflects the level of importance of each topic relative to the other topics in the list and is based on: 1). its importance to resource management in the park, or 2). the need to obtain additional information about the specific geologic feature or process.

Permafrost Features and Processes

Permafrost is composed of soil and rock that have been at a temperature of 32°F or colder for 2 or more years. A delicate heat balance exists between permafrost and the “active layer” above it. Thus, changes in the vegetative mat, snow, or other characteristics of the upper layer can significantly alter the thermal regime, with resultant changes at ground level. This can cause melting of permafrost. In addition, an increase in solifluction, or soil movement, is possible. These phenomena can cause heaving, sagging, soil slumping, and erosion at the surface during successive periods of freeze-thaw in the active layer. The result can be detrimental to infrastructure including buried cables, utility poles, paved surfaces, and roadbed foundations. The term “thermokarst” describes a landform developed when permafrost is partially or totally melted. Thermokarst is highly irregular and forms variously shaped polygonal depressions. Thermokarst has been created in parts of Alaska due to construction projects.

- Permafrost covers entire north side of park
- Features:
    - thermally unstable feature – Yedima
    - patterned ground – alteplanation (long smooth flat ridges)
    - thermokarst features are abundant (polygons and ice wedges)
    - Periglaciers
- Solifluction
- Permafrost is a major controlling factor on surface water and vegetation (high ecological importance)

Management Issues / Concerns:

Affects on wetlands and anything associated with wetlands, potential damming of streams by mass movement, subsequent catastrophic failure of dams, downstream impacts

Inventorying / Monitoring Needs:
- USGS monitoring – interested in contacting Clow re: weather stations / climate change studies
- Interpret surficial maps to infer what happens with loss of permafrost
- Permafrost core map needed, everything mapped below X road at WRST
- Difficult to monitor, tends to destroy permafrost

Contacts:
- Guy Adema – DENA, (907) 683-6356
- Danny Rosencrans, WRST, (907) 823-7240

Glacial Features and Processes

20-25% of WRST is covered by glaciers (4 million acres or approximately 5000 square miles), park contains valley, piedmont, tidewater, rock, and surging glaciers

The Nabesna Glacier is the world's longest interior valley glacier (over 75 miles long), the Malaspina Glacier is North America's largest piedmont glacier (nearly 40 miles across), and the Hubbard Glacier near Yakutat is the longest tidewater glacier in Alaska (over 76 miles long with an open calving face covering over 6 miles)

Features: cirques, horns, arête ridges, medial and terminal moraines, outwash plains, icebergs

Glaciers create micro climates that support unique floral and faunal habitats; refugia and nunataks – important role in biological diversity

Past 200 years – the area has transitioned out of little Ice Age; glacier retreat moving into incised regime, impacts on fluvial systems

The study of glaciers in WRST should be grouped in the following categories:
- Glaciology - dynamics of ice (advance, retreat, thickening and thinning)
- Glacial extents – where are glaciers located, how much has melted, amount of ground covered by glacier, length of time covered by ice, extents are being monitored on representative glaciers elsewhere in NPS; WRST does no glacial monitoring at this time
- Glacial geology – Holocene glacial features and history

Stressor: climatic change

Management Issues /Concerns:
- Hubbard Glacier is blocking the outlet of Russell Fjord, creating Russell Lake, fear of failure/flooding, potential harm to trout habitat, public health and safety issue and threats to the local airport; annual event is monitored, limited management actions beyond public warning system
- Park boundary changing with retreat of glacier (Icy Bay area)

Inventory / Monitoring Needs:
- Determine historical extent of glaciers- this could be done by digitizing glaciers on topographic maps (1957, 1983 vintage maps); Bill Manley at INSTAR – resource for glacial extent GIS applications (example of Central Alaska range digitized off of photos); USGS and park did geomorphic study of Kennecott Glacier looking at last 100 years
- Icefield archeology - as glaciers (or snow pack or neve) retreat, underlying cultural resources are exposed; park has researcher working at terminous of icefield looking for artifacts (James Dixon, CU)
- Interpretation of land cover change

- Repeat photography - continued work by Hal Pranger and Ron Karpilo (similar to work that was done at GLBA), move into other parks; includes an interpretive component – how glaciers are changing through time; impacts on parks; information for interpretive staff
- Climatic change - use ice core data points to look at climatic change

Contacts:

- Guy Adema – DENA, (907) 683-6356
- Danny Rosencrans, WRST, (907) 823-7240

Fluvial Features and Processes

Copper River is the major watercourse in the region, forming the western boundary of the park/preserve. Other fluvial systems include the White, Nabesna, Tanana, Chitina, Kotsina, Bremner, TeBay, and Hanagita Rivers; and Beaver and Cabin Creeks.

Management Issues / Concerns:

- Human development on alluvial fans, since fans are dynamic and development on alluvial fans inhibits natural processes, it puts infrastructure and public health and safety at risk. McCarthy – alluvial fan threatens entire town, including roads and private property; trying to balance natural processes with in-holder’s needs; NRCS is helping town with design to stabilize; parks involved with management of alluvial fans only if they lie on park lands
- Fish issue – habitat affected by developing on alluvial fans and in floodplains

Paleontological Resources

Permian to Tertiary-aged fossils, limited topical studies, tremendous resource, big unknown

Known fossiliferous formations: Fredricka Fm.

Cretaceous rocks in CAKN parks are significant, they are the only place to study high latitude fauna

Three types of paleontological resources: paleo-botany, invertebrate paleontology, and vertebrate paleontology (most valuable fossils on open market)

Management Issues / Concerns:

- Protection of paleontological resources in park, particularly easily accessible areas along roads / trails

Inventory / Monitoring Needs:

- Reconnaissance survey
- Create paleontology GIS layer; use to display as dot and zone maps; differentiate between vertebrate and invertebrate fossils, rank each area by quantity and likelihood of poaching

Contacts:

- Robert Blodgett – USGS
- Greg McDonald – NPS-GRD, (303) 969-2821

Cave and Karst Features and Processes

Distribution: Triassic Chitistone Limestone, Jurassic Nizina Limestone, other limestone units in the park (Pennsylvanian and Devonian), unknown if there has been any investigation of these units

Mostly in backcountry, not accessible to public; caves not explored, only a few looked at in any detail

2nd longest cave in Alaska is in WRST

Management Issues / Concerns:

- -Unique cave formations, may be issue with park visitors/cave groups

Inventory / Monitoring Needs:

- -Need geologic map coverage to identify all carbonates, particular the Triassic Chitistone and Jurassic Nizina Limestones (over 200 miles of exposure of these two units)

Biological Associations: usually nutrient rich, provide habitat

Pleistocene vertebrate/cultural associations

Cave / Karst resources: website of WRST caves (Curvin Metzler); some maps in park files, quarterly local grotto publication

Contacts:

- Ron Kerbo – NPS-GRD, (303) 969-2097

Aeolian Features and Processes

Aeolian features found in 4 areas of the park: Sanford Dunes, Tana Dunes, Bremner Dunes, coastal dunes
Active dunes are a unique park feature, two are advancing systems,
Contain paleo-climate information (Tana and Sanford Dunes) from exposed vegetation (unknown relationship to climate change)
Management Issues / Concerns:

- Interpretive needs
- Holocene climate information

Geothermal Features and Processes

Three mud volcanoes in the park (40o F, 86 o F, 125 o F degrees), extend 100’s of feet high
Thermal springs investigated for energy potential, elevated water temperatures on the flanks of Mt. Wrangell
Geothermal areas produce microclimates
Management Issues / Concerns:

- Lower and upper Klawasi sites – emits high CO^2 sufficient to kill vegetation, animals, and birds, pose some visitor risk, although seldom visited, Alaska Volcano Observatory (AVO) has put out notice on these sites,

Interpretive component: connection to fossils - water percolates through 500+ meters of Pleistocene sediments, emergent water/muck is fossil rich, Alaska Volcano Observatory (AVO) is monitoring these occurrences, all have been mapped

Lacustrine Features and Processes

Six large water bodies, over 500 large shallow ponds in WRST, pro-glacial Lake Ahta
Glacial pans – not as many retaining water as in the past, can see changes, changes resident use patterns, wildlife populations,
Inventory / Monitoring / Research Needs:

- distribution and classification of lakes: PMIS proposal has been submitted to review historic data sets, map water distribution
- Lake cores to determine Holocene record; some lakes have been cored by outside researchers (Linda Brubaker from WSU), 4 or 5 lakes cored, effort to get Finney (UAF) involved

Hillslope Features and Processes

Landslides - large, frequent slides in WRST (6 slides cover 2.5 $mi.^2$)
Primarily associated with loss of permafrost, clay dewatering, some caused by earthquakes, over-steepening of slopes, or associated with Cretaceous black carbonaceous shales
Two examples: Nelson Mountain Slide, West Fork Slide
Landslides are a major factor in landscape formation
Inventory / Monitoring Needs:

- Map distribution of landslides from surficial geologic map
- Use GIS, compare landslides with surficial and bedrock geology

Volcanic Features and Processes

Wrangell Volcanic Field: covers 4,000 square miles, there are at least 12 known volcanic centers which range in age from 26 million years old to currently active (most recent volcanic activity was in 1930). Mt Wrangell is the only active volcano in the park, it is the oldest and largest caldera in park, steam rises out of the vents situated in craters along the margin of the summit caldera, there are seismic stations on Mt. Wrangell
Churchill – 40 miles SE of McCarthy, source of 200 year old White River Ash, AVO did volcano hazard assessment of these two volcanoes

Resource Management Issues / Concerns:

- lahars on the flanks of Mt. Wrangell

Inventory / Monitoring Needs:

- USGS has 4-6 seismic stations on Mt. Wrangell, these are checked twice a year
- inventory hot springs
- interpretative materials for park visitors

See USGS bulletin on volcanoes

Seismic Features and Processes

Park is an assemblage of accreted terrains, from oldest to youngest the terranes include: Yukon-Tanan Triassic – Jurassic), Wrangellia (Cretaceous), Chugach (Upper Cretaceous), Prince William (Eocene), and Yakutat Terranes (Miocene to Pleistocene).

Mt. Wrangell area is aseismic

Big threat - significant earthquakes have occurred in the area in the past 100+ years (1899, 1958, 2002) extensive monitoring system and tsunami warning system in-place, limited infrastructure in park would be damaged

On November 3, 2002 a massive 7.9 magnitude earthquake located in the central Alaska Range extended eastward along the Denali and Toshunda faults and rocked the northern district of WRST. The epicenters of the Neanna/Denali earthquakes were outside park, but the rip zone extended into the park. Displacement of the fault reached 5 meters in places. This earthquake caused incredible changes to the topography of the region. Bedrock fractures were reactivated, cracks appeared in the surface and mountainsides, and huge mudslides came down many slopes.

Inventory / Monitoring Needs:

- USGS / Geophysical Institute UAF monitors aseismic gap, interested in why there is no seismic activity here, significant seismic activity on either side of the park
- Monitoring aftershocks along 2002 quakes
- Strain network set up in state, numerous stations in the park

Unique Geologic Features

Rock glaciers
Landslides
Type sections
Mud volcanoes
Outburst lakes
Periglacial features
Pro-glacial Lake Ahtna
Sand dunes
Tidewater glaciers (e.g. Hubbard Glacier)
Kennecott ore deposits
Semi precious stones (mineral collecting locations)

Minerals / Disturbed Lands

The following summary of mining in the park is an exerpt from the 1986 park General Management Plan: The most famous copper mines in Alaska were in the Kennicott deposits within the park/preserve near the mining towns of Kennecott and McCarthy. As a single unit they constituted one of the richest copper deposits in the world (Alaska Department of Commerce and Economic Development 1982). At their height of production in 1916 the mines were producing 175 tons of crude ore per day, averaging 70 percent copper. When the mines were abandoned in 1938, the total production was over 590,000 tons of copper and about 9 million ounces of silver (produced as a byproduct). This constitutes nearly 86 percent of the state's copper production and almost half the silver production (U.S. Bureau Mines 1975).

However, due to market conditions, the Wrangells area has not been a profitable copper mining area since Kennecott was abandoned in 1938.

The whole south side of the Wrangell Mountains has potential for high grade copper and silver deposits (U.S. Bureau of Mines 1975). The north side of the Wrangells has the potential for molybdenum, lower grade copper, and gold. Major deposits on the north side center around Nabesna and Chisana. There are also chromite deposits at Spirit Mountain near Chitina.

The Copper River basin near Glennallen has some potential for oil and gas (USDI, GS 1982). The southern coastal area has potential for oil and gas and uranium resources (U.S. Bureau of Mines 1975). There appears to be little if any potential for coal resources within the park/preserve boundaries.

Mining:

Mining included base and precious metals (mainly copper and gold).
Mining districts include: Nabesna, Chisana, Kotsina Kuskalana, McCarthy Nizina, and Bremner Districts.
The Kennecott mines have been placed on the National Register of Historic Places.
2500 unpatented claims existed when the park was established; currently there are 299 patented claims, 27 unpatented claims, and 3 approved mining operations in the park (patented/unpatented data from GRD mining database 12/03)
According to the GRD's AML database, there are 404 mine sites in need of reclamation in the park.
Impacts: cat tracks, mine openings, drill pads, superfund sites, remnants of placer mining
Debris has been cleaned up at several sites, mine adits have been closed, explosive sites removed
Superfund sites:

- Sudden Stream (BP O&G site) - reclaimed
- Kennecott site - NPS is lead federal agency, active issue
- Nabesna – to be addressed, significant legal issues associated with private land, owner is part of the process, settlements reached will need to be DOJ, DOI, and NPS; huge regulatory morass

Oil and Gas:

State oil and gas tracts in Copper Basin are planned for lease offering
5 year MMS offshore leasing cycle in southern, offshore portion of the park

Disturbed Lands:

Logging – increased sedimentation in waterbodies
Grazing – widespread, limited impact
ATV trails – 623 miles, hundreds of miles of trails are inactive, unlikely that trails will be reclaimed, in GMP recreational use was considered traditional use, permit recreational use of ATVs on 13 existing trails; subsistence use permitted on all trails if it results in no resource damage
Trespass / inholdings – 15 miles of newly bladed road/trails
Contacts:

- Dave Steensen – NPS-GRD (disturbed lands restoration) (303) 969-2014

Cultural Issues Related to Geology

Potential sources of obsidian and chert for tools
Late 1800's USGS publication shows historic trails; these trails mimic Native Alaskan trails, historic information contained in these early geologic publications is invaluable, trails could be digitized
Holocene glacial record – where shown on maps, it indicates location of glaciers, if digitized could show the advance/retreat of glaciers
Surficial deposits show paleo features, in particular shoreline for pro-glacial Lake Ahtna
Database of historic photo information – USGS is an important and untapped source of cultural information

Biologic Issues

Identify extent of glaciers in the Pleistocene, related to present-day refugia

Geologic Education/Outreach/Interpretation

Long range interpretive plan for the park has 10 interpretive themes, 6 are related to geology
Geology ties the interpretive thread together in the park
Park needs to get interpretive staff up-to-speed with respect to geology
Educational outreach has significant geologic component
Need Geoscientist-in-Park (GIP) to assist interpretive staff and to produce 6-12 fact sheets addressing basic geologic themes

The following questionnaire, prepared by park staff (Devi Sharp and Danny Rosenkrans) addresses the interpretive needs of Wrangell-St. Elias staff and visitors:

1. What are the primary and secondary interpretive themes in your park?
   Primary interpretive themes related to geology:
   - Kluane National Park, Wrangell-St. Elias National Park and Preserve, Glacier Bay National Park and Preserve and Tatshenshini-Alsek Provincial Park make up a world heritage site, one of the largest terrestrial protected areas in the world in which natural processes function relatively undisturbed.
   - Wrangell-St. Elias National Park and Preserve's dynamic natural landscapes provide opportunities to study and witness the processes of biodiversity and wildlife ecology as well as the dynamic forces of weather, water, glaciers, plate tectonics and volcanism.
   - Wrangell-St. Elias National Park and Preserve is an inhabited wilderness where human activity and cultural values remain integrated with natural processes.
   - Wrangell-St. Elias National Park and Preserve's vast size, high peaks, glaciers and wilderness provide world class opportunities for discovery, reflection, unconfined recreation and adventure in a remote setting.
   - Mineral extraction was a driving force behind Euro-American exploration and settlement of the Copper Basin and influenced and was influenced by national and international events and economies.
   - Since prehistoric times the Wrangell-St. Elias region has been home to many peoples ranging from Ahtna and Upper Tanana, Eyak and Tlingit to Euro-American settlers; each has developed and continues to develop different socioeconomic lifestyles based on its unique relationship with the area's rich diversity of resources.

2. What geologic topics are included in these interpretive themes and how are they being interpreted:
   Note on ways things are being interpreted…just because we have all these things on these topics doesn't mean we have interpretation in all of our visitor locations. We are off to a great start but are lacking some types of interpretation in our different locations (we can talk more about specifics).

   -<u>Geologic Features</u> (volcanic edifices, ice age landforms, natural arches, etc) 1, 3, 4, 5, 6, 7, 8 (brand new), 9, 10 (pending)
   - Ancient (eroded), dormant and active volcanism
   - Geologic terrains and the formation of the theory of plate tectonics
   - Glaciology, climate change, and glacial recession (can see glacial trim line, and have photos of larger glacier, have lots of glacial formation and flow pictures etc.)

   -<u>Geologic Processes</u> (active volcanism, glaciation, coastal, fluvial, erosion, etc) 1, 3, 4, 5, 6, 8 (brand new), 9, 10 (pending)

- Rapid glaciological, hydrological, and landform processes
- Glacial outwash flooding - Hidden and Iceburg Lakes (history, process, relation to glacial recession, changing river environment, hazards etc.)
- Rapid advancement, process, hazards etc - Hubbard Glacier
- Mass wasting - large and small scale slumps and slides - example: slide over road between McCarthy and Kennecott and West Fork of the Nizina River slide.
- Coastal - Ask J.

-<u>Geologic Issues</u> (mining, abandoned mines, cave management, geohazards, etc) 1, 3, 4, 5, 6, 8 (brand new), 9, 10 (pending)

- Mining-formation of ore, mining process and history, place in time and economy, use of mineral.
- Abandoned mines - safety messages and history
- Geohazards - safety messages - rivers, abandoned mines.

How is each geologic topic being interpreted (mark number next to each topic):
0 - Not interpreted in park.
1 - Wayside exhibits
2 - Museum exhibits
3 - Free publications (site bulletins, park newspapers)
4 - Sales publications (brochures, park geology books)
5 - Personnel services (walks, talks)
6 - Audio visual programs (films, video tapes)
7 - Trail guide/self-guided trail
8 - Jr Ranger/Jr Geologist program
9 - Educational Outreach program
10 - WWW Homepage
11 – Other

3. What other geologic features, processes, or issues are in your park that you are not currently interpreting?
I think we do a little of everything but increasing our effectiveness with the above list will help a lot, i.e. Result in a more comprehensive approach. For example, every year we do a lot of informal interpretation about the Hidden Lake jokulhlaup as it is happening, however, if we had a great diagram that helped explain the process it would help our live programming as well as give us a great graphic to use in a site bulletin (topic publication) that we could hand out as the event happens. It would be a very powerful tool for a week each summer.

4. How would you rate your geologic interpretive program? 2 - For the size of our program we have a large geological focus.
1 - Excellent
2 - Good
3 - Adequate
4 - Needs Improvement
5 - No current program

5. Are there active "partnerships" or other programs to interpret geologic resources in your park? (yes/no) If yes, what are they? Yes! The Wrangell Mountains Center has a huge geological, glaciological, river component to their college field studies program. WISE/NPS education program often have geological components for the elementary school age students in the valley.

6. Do you currently have adequate stratigraphic columns and/or diagrams explaining your park's most important geologic topics? (yes/no/they are available but are inadequate). NO. Graphics

that can be used for interpretive props, publications and exhibits created in house would be very helpful. Danny has a list.

*During the scoping meeting the park identified the creation of geologic fact sheets as the greatest interpretive need.

7. Do you now have or do you plan to develop a curriculum based (school) educational program that deals with geologic resources?
_x__ Have a geology EE program
____ Developing or planning a geology EE program
____ No geology EE program

8. What are the obstacles to the interpretation of geology in the NPS? Please rank each issue 0 - 5 (0 = no obstacle; 5 = maximum obstacle):
_2__ Lack of available geology information.
____ Lack of visitor interest.
_1__ Lack of basic geologic background among interpretive staff.
_3__ Lack of communication between resource management/research and interpretation.
____ Lack of communication between geoscientists and interpretation.
____ No geoscientists on park staffs.
____ Difficulty/complexity of subject.
_5__ Lack of interpretation funding/staffing.
_4__ Other. Specify: Lack of graphics

9. In your opinion, what measures should be taken to improve geologic interpretation in the NPS? Funding for interpreters and publications, training of interpreters.

In this park I would add increased availability of information, and graphics for use by interpretation, (or graphic arts training for interpreters to be able to develop them).

10. What would you like to see the GRD do to promote geologic interpretation? Rank each type of assistance needed 0 - 5 (0 = not needed; 5 = needed the most):
_2__ Obtain geologic research.
_1__ Summarize scientific findings.
____ Locate geoscientists to fill vacancies or VIP positions.
_3__ Provide technical assistance for geology publications or programs.
____ Develop partnerships between parks and geoscientists or geoscience organizations.
____ Develop Web site geology information.
____ Assist in development of lesson plans/activities for educational outreach programs and/or Jr Ranger.
____ Help obtain slides of geologic features and/or geologic samples for park interpretive collections.
_5__ Assist in development of training for interpretive staff.
____ Clarify NPS policy/regulations on geologic/paleontologic research/use.
____ Advise on geohazards.
_4__ Assist with obtaining funding (grants, etc.) for geologic interpretation.
____ Other. Specify:

Additional Comments:
In terms of helpful products: General things that we can use in several different interpretive formats would be much more helpful than a specific product that we can't adapt in to our program. For example, diagrams or visuals that can be used in articles, publications, live program props, Power Point presentations and training materials are more helpful than a completed publication. Also, there is general agreement that there are lots of curriculum

materials on the market that can be adapted to our site. We do not need someone to develop another curriculum for us.

The following visitor/interpretive quality visual diagrams (aka "fact sheets") would help the park in the development of training materials for NPS and partner interpreters as well as local business, seasonals, live interpretive programs, publications, waysides and exhibits:

1. Process of the annual Hidden Lake Jokulhlaup
2. Terranes and the development of the theory of plate tectonics
3. Formation of the Kennecott Ore
4. Superimposition of the Wrangell Volcanic Range on the Wrangell Range
5. Development of the Wrangell Volcanic Range and the subsequent inactivity (i.e. see the volcanic driver moving west) lateral blast, glacial erosion etc…this may take more than one graphic.
6. Lake Ahtna and its relationship to the surrounding mountain ranges and subsequent formation of river systems
7. Skookum volcano (what it used to look like and today's plumbing)
8. Advancement/recession history of the Hubbard Glacier
9. Variety of angles (aerial, oblique) of the mountain ranges of the park
10. Simple terrane map
11. Geologic history of the park

Staff training materials interpreters can develop this information into interpretive products but a compilation of research and facts into reference and training materials would be very helpful.

1. Top ten geological sites in the park and their geologic story (what is really significant and gets geologists excited about this park)
2. Geological superlatives - the actual facts!: how much ice, how big is the Malaspina glacier and is it the biggest? What about the Nabesna, etc.
3. Geological descriptions of major processes for seasonal training notebooks. Two pages each on volcanic history, terranes and the theory of plate tectonics, Kennecott ore formation, formation of the Chitistone limestone and Nikolai Greenstone, etc. These don't need to be interpretive (that can be the interpreter's job) but they need comprehensive information (2 pages or more is fine).

Park Contact Information

Park Name: Wrangell-St. Elias National Park and Preserve
Address: 106.8 Richardson Highway, P.O. Box 439, Copper Center, AK 99573-0439
Superintendent: Gary Candelaria (907) 822-7210
Chief of Resources: Devi Sharp, (907) 822-7212
Chief of Interpretation: Smitty Parratt (907) 822-7223
GIS Contact: Joni Piercy (907) 644-3554
Geoscientist: Danny Rosenkrans, (907) 822-7240

Denali National Park and Preserve

Executive Summary

During the Geologic Resources Evaluation scoping meeting, National Park Service park and regional staff identified the following geologic digital mapping needs and key resources management issues/needs:

Geologic Mapping:

5. currently, the USGS has recent published digital geologic maps at a scale of no less than 1:250,000 for all six 1x2 degree quadrangles of interest (Fairbanks, Kantishna River, Healy, Mount McKinley, Talkeetna Mountains, and Talkeetna) for DENA contained in OF-98-133, all of which need to be "converted" into the NPS-GRE Digital geologic map model for maximum utility by NPS staff

6. Phil Brease has requested GRE staff to digitize Plates 2, 3, 4, and 6 from USGS Professional Paper 293 (Wahrhaftig, Clyde, 1958, Quaternary geology of the Nenana River Valley and adjacent parts of the Alaska Range: U.S. Geological Survey, Professional Paper 293, scale 1:250000). He was also interested in incorporating some newer geologic mapping of the Mount McKinley 1x2 degree sheet that he was aware of done by independent contractors

7. The ADGGS has recent publications treating the geology of the Chulitna and Petersville regions that should be incorporated into a master DENA digital geologic map

Geologic Resource Management:

(With the exception of the road corridor in the park, human safety and resource impacts were not identified as major resource management concerns in the park.)
Assistance interpreting unique geologic features
Disturbed lands, mining (in-holdings) – restoration, clean-up
Paleontological resources – lack of information, want inventory completed
Permafrost – resource management concern related to design and construction of park infrastructure
Glaciers – significant drivers of landscape

Introduction

Congress established Mount McKinley National Park on February 26, 1917 as "… a public park for the benefit and enjoyment of the people… for recreation purposes by the public and for the preservation of animals, birds, and fish and for the preservation of the natural curiosities and scenic beauties thereof … said park shall be, and is hereby established as a game refuge." (39 Stat. 938). In 1922 and 1932 subsequent legislation expanded the park boundaries to the east and north, including lands in the Wonder Lake area for the purpose of protecting winter game habitat, especially moose.

In 1980 Congress passed and President Carter signed the Alaska National Interest Lands Conservation Act (ANILCA). Section 202(3)(a) of ANILCA added about 3.8 million acres to Mount McKinley National Park and renamed it as Denali National Park and Preserve. The park/preserve is to be managed for the following purposes:

> *To protect and interpret the entire mountain massif, and additional scenic mountain peaks and formations; and to protect habitat for, and populations of fish and wildlife including, but not limited to, brown/grizzly bears, moose, caribou, Dall sheep, wolves, swans and other waterfowl; and to provide continued opportunities, including reasonable access, for mountain climbing,*

mountaineering and other wilderness recreational activities. Subsistence uses by local residents shall be permitted in the additions where such uses are traditional.

Section 701 (1) of ANILCA established the Denali Wilderness of approximately 1.9 million acres, which covers all of the former Mount McKinley National Park minus the park entrance area and road corridor to the old boundary near Wonder Lake with various development nodes along the road corridor.

The park is physically dominated by Mount McKinley and an east-west trending line of towering mountains known as the Alaska Range. The Alaska Range forms the northernmost portion of the Pacific Mountain System and is one of the great mountain ranges in North America, rising from 500 to 2,000 feet to the pinnacle of Mount McKinley at 20,320 feet. Numerous other peaks near Mount McKinley reach elevations ranging from 10,000 to 17,000 feet. These peaks have permanent snow cover above approximately 7,000 feet on the north side of the range and support several large glaciers. The largest glacier on the north side of the range is the 34-mile-long Muldrow Glacier, which extends northward toward the road corridor in the area west of the Eielson Visitor Center.

North of the Alaska Range is a series of east-west trending foothill ridges, which extend eastward from the Kantishna Hills north of Wonder Lake. The foothills area ranges from 3 to 7 miles wide, and has summit elevations generally between 2,000 and 4,500 feet. The foothills are separated at intervals by broad, flat, glacial valleys that generally drain from south to north.

Geologic Overview

Geologically, Denali National Park and Preserve is significant because it contains:

- Mount McKinley (20,320’), the highest mountain in North America and towering peaks of the east-west trending Alaska Range,
- Widespread glaciation, covering 1 million acres of the park, the longest glacier in the park and Alaska Range is the Kahiltna Glacier (44 miles long),
- Extensive glacial features,
- Presence of discontinuous permafrost, and
- Ruth Gorge – the deepest gorge in North America.

The Alaska Range is the dominating feature in Denali National Park and Preserve. The Alaska Range is a syncline, locally altered by complex folding and faulting. The Denali fault system runs parallel to the axis of the regional synclinal structure, trending west-southwest, and has been mapped from southwestern Alaska along the Alaska Range to the Canadian border. Movement along the fault system began in the Cretaceous, has continued to the Recent, and can be seen in fault scarps and offset stream gravels (Wahrhaftig, 1965).

The Alaska Range was formed during strong orogenic activity that ranged from the Jurassic through the Tertiary, with the climax of the mountain building occurring during the Late Cretaceous (Wahrhaftig, 1965). The Kantishna Hills Mining District is located in the northern foothills of the Alaska Range, and is within the Yukon-Tanana tectono-stratigraphic terrane (Jones et al., 1981), formerly referred to the as the Birch Creek Schist (Prindle, 1907). These rocks are thought to be the basement complex of much of interior Alaska. Recent magnetotelluric evidence suggests that Yukon-Tanana lithology underlies the Alaska Range and may extend as far south as the Central Susitna Basin (Stanley, 1986).

The Pacific plate has been acting like a conveyor belt for hundreds of millions of years, bringing bits of islands, ocean floor, and slivers of other continents northward to form accretionary terranes in Alaska which are pieced together like a jigsaw puzzle. This is an ongoing process today, as the Pacific plate moves northward, colliding with Alaska at about 5 centimeters per year. New "additions" to Alaska are, of course, a very slow process, and to most people, even the most recent addition (the Yakutat block, along the southeast coast of Alaska) does not show any obvious evidence of collision and accretion.

However, most of the terranes are identified as packages of rocks that are surrounded by faults, and have different rock types, fossils, and other physical properties, unlike their neighbor terranes.

The oldest terrane and rocks in the park are found near the park entrance, and are called the Yukon-Tanana rocks. These are shallow sediments with volcanic flows and intrusions (molten injections of rock) that formed in a very young Alaska, about 400 million years ago. These rocks have been buried very deeply for a long time, and subjected to heat and pressure that metamorphosed the rocks into schists, phyllites, and gneisses.

For the next 300 million years, ocean environments continued to dominate the area around Denali, where marine shelf, slope and basin materials accumulated or accreted to become the shales, limestones and sandstones of the Farewell terrane. These ocean sediments comprise the great mountains in the eastern portion of the park, such as Mount Pendelton and Scott Peak. Fossils found in the Farewell terrane suggest that during deposition of some of the sediments, the climate was very tropical, and lush coral reefs and other warm water fauna flourished.

Among the exotic terranes in Denali are those referred to as island arcs (volcanic island chains, like the Japanese islands), which are identified by having volcanic and marine sedimentary rocks on top of each other. The 200 million year old Pingston and McKinley terranes are possibly from an island arc environment. Pillow basalts (lava extruded under ocean water, forming pillow shaped features) can be seen in the roadcut on the park road just west of Eielson Visitor Center.

During the birth of Mt. McKinley 56 million years ago when molten magma solidified deep beneath central Alaska, volcanic activity (eruptions at the surface) was also occurring in the park, and produced red, yellow and brown basalts, rhyolites, and other volcanic rocks. These rocks can be seen along the park road, particularly at Polychrome Pass. This area was named for the colorful volcanic rocks exposed there. Another period of volcanic activity occurred at Denali about 38 million years ago, and basalts and andesites found exposed at Mt. Galen, and along the park road at the west end of Eielson Bluffs were deposited. Similar to Mt. McKinley, another granitic intrusion became Mt. Foraker, the second tallest peak in the park at 17,400 feet (5303 meters).

A series of faults have fractured the park and most of the state in the last 100 million years. In Denali, this group of faults is known as the Denali fault system, which arcs east-west through the park (and most of the state) for 720 miles (1200 kilometers). Portions of the fault trace are visible within the park at Bull River divide, Easy Pass, and other locations.

DENA Geologic Mapping

As mentioned earlier, the existing USGS OF-133-a contains digital geologic mapping for all six 1x2 degree sheets of interest for DENA as follows: Fairbanks, Kantishna River, Healy, Mount McKinley, Talkeetna Mountains, and Talkeetna. Of these, the Mount McKinley is the only dedicated sheet where all the larger scale 1:63360 quadrangles are quadrangles of interest. At a larger scale, DENA has (58) 1:63,360 scale quadrangles of interest.

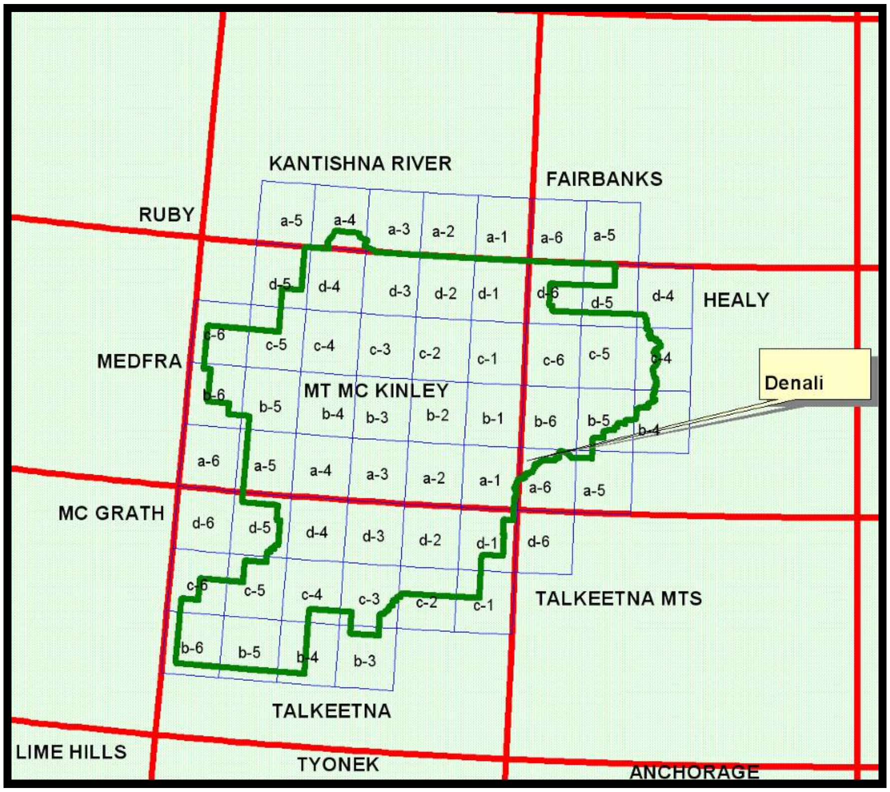

Figure 10. 1 x 2 degree (250,000 scale) sheets for the DENA area shown in black outline and lighter green backfill with name of sheet; 63,360 sheets shown in blue outline without subdividing quadrangle names; DENA boundary in green

PUBLISHED GEOLOGIC MAPS
(quadrangle and non-quadrangle based)

Larger scale
At the larger scale of 1:63,360, USGS Professional Paper 293 (*Wahrhaftig, Clyde, 1958, Quaternary geology of the Nenana River Valley and adjacent parts of the Alaska Range: U.S. Geological Survey, Professional Paper 293*) contains two plates (2 and 4) that Phil Brease specifically sought to have in a digital format (GRD is currently digitizing these, and two others: Plates 3 and 6; smaller scale). The specifics on these plates is as follows:

- *Geologic Map of Parts of Healy D-4 Quadrangles, Alaska, Showing Pleistocene Deposits Along the Nenana River (Plate 2); 1:63,360 scale*

- *Quaternary geology of the Nenana River Valley and adjacent parts of the Alaska Range (Plate 3); 1:250,000 scale*

- *Geologic Map of Part of Healy B-4 Quadrangle, Alaska, Showing Quaternary Deposits Along the Nenana River (Plate 4); 1:63,360 scale*

- *Map of the Alaska Range Between Longitude 147 degrees 30' and 150 degrees West, Showing Glacial Features (Plate 6); 1:250,000 scale.*

At the present time, GRE staff in Denver are digitizing these maps and will supply them to DENA when they are completed (estimated to be end of FY-2004).

Additionally, the Healy D-4 (*Wahrhaftig, Clyde, 1970, Geologic map of the Healy D-4 quadrangle, Alaska, U.S. Geological Survey, Geologic Quadrangle Map GQ-806, 1:63360 scale*) and Healy D-5 quadrangles (*Wahrhaftig, Clyde, 1970, Geologic map of the Healy D-5 quadrangle, Alaska, U.S. Geological Survey, Geologic Quadrangle Map GQ-807, 1:63360 scale*) have been published, and hopefully are incorporated into USGS OF-133-a as best as possible. USGS OF-74-147 (*Csejety, Bela, 1974, Reconnaissance geologic investigations in the Talkeetna Mountains, Alaska, U.S. Geological Survey, Open-File Report OF-74-147, 1:63360 scale*) is just outside the DENA quadrangles of interest, but could be useful; again it’s not known if this has already been incorporated into USGS OF-133-a.

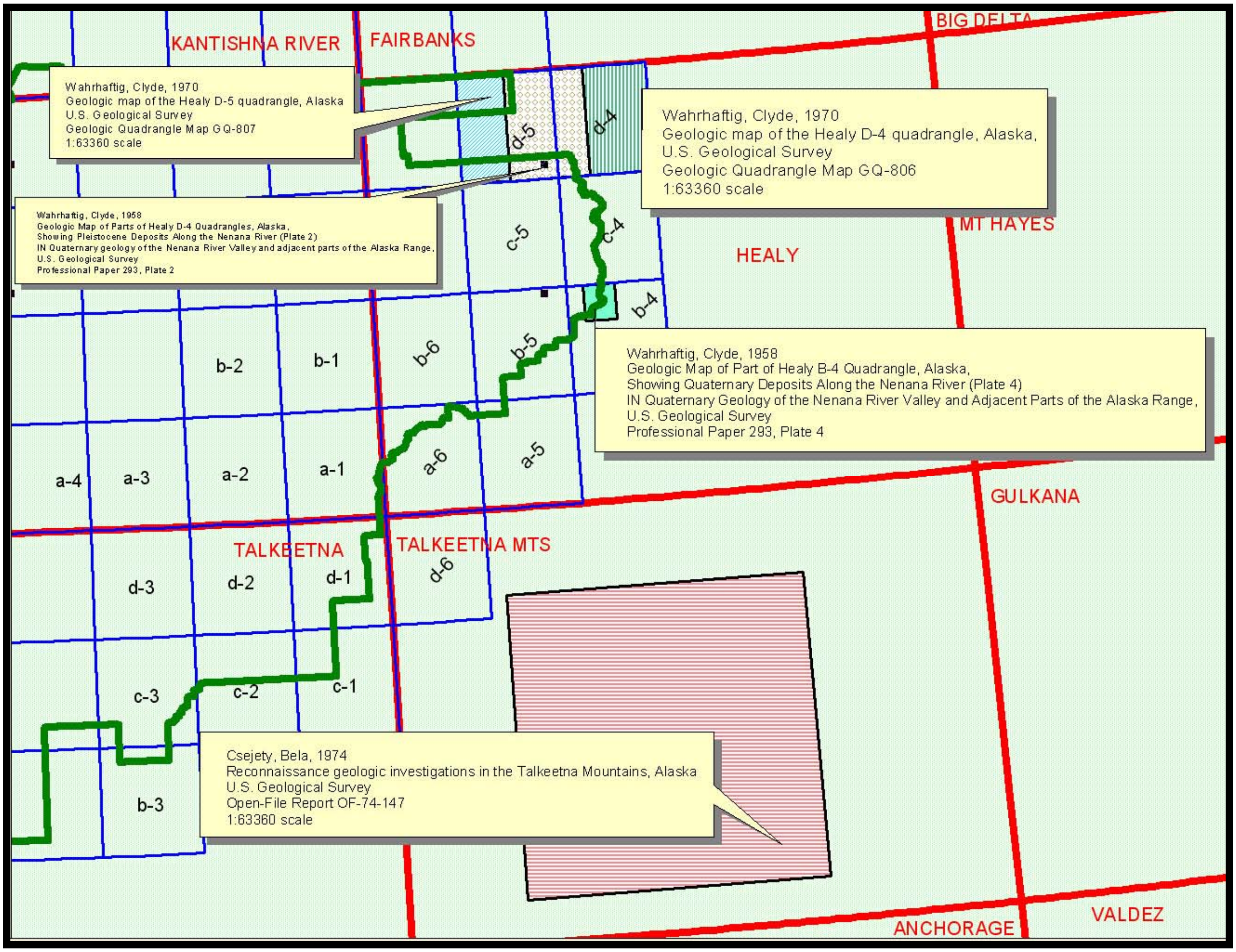

Figure 11. Known Geologic Maps at 1:63,360 scale

Additionally, in 2001, the Alaska Division of Geological and Geophysical Surveys published a 4-fold series of geologic maps of the Chulitna Region, which is located in the southwest portion of the Healy 250,000 sheet. During the scoping meeting it was suggested to contact Fred Sturman at the ADGGS to obtain the digital GIS files for subsequent maps from these publications. Tim Connors requested the digital files from Fred Sturman, and has received them in EOO and shapefile formats. GRE staff are currently evaluating these files for incorporation into the NPS-GRE model.

Also, the ADGGS has published a series for the Petersville (Yentna) mining district that occurs within the Talkeetna 250,000 sheet as follows:

- *Reger, R.D., Combellick, R.A., Pinney, D.S., 1999, Reconnaissance map of glacial limits in the Petersville (Yentna) mining district, Alaska: Alaska Division of Geological & Geophysical Surveys, Report of Investigation 99-7, 1 sheet, scale 1:63,360.*

- *Reger, R.D., Combellick, R.A., Pinney, D.S., 1999, Reconnaissance surficial-geologic map of the Petersville (Yentna) mining district, Alaska: Alaska Division of Geological & Geophysical Surveys, Report of Investigation 99-9, 1 sheet, scale 1:63,360.*

- *Szumigala, D.J., Pinney, D.S., LePain, D.L., Liss, S.A., Burns, L.E., Clautice, K.H., Mayer, J.L., McCarthy, A.M., 2000, Interpretive bedrock-geologic map of the Petersville (Yentna) mining* *district, Alaska: Alaska Division of Geological & Geophysical Surveys, Report of Investigation 2000-03, 1 sheet, scale 1:63,360*

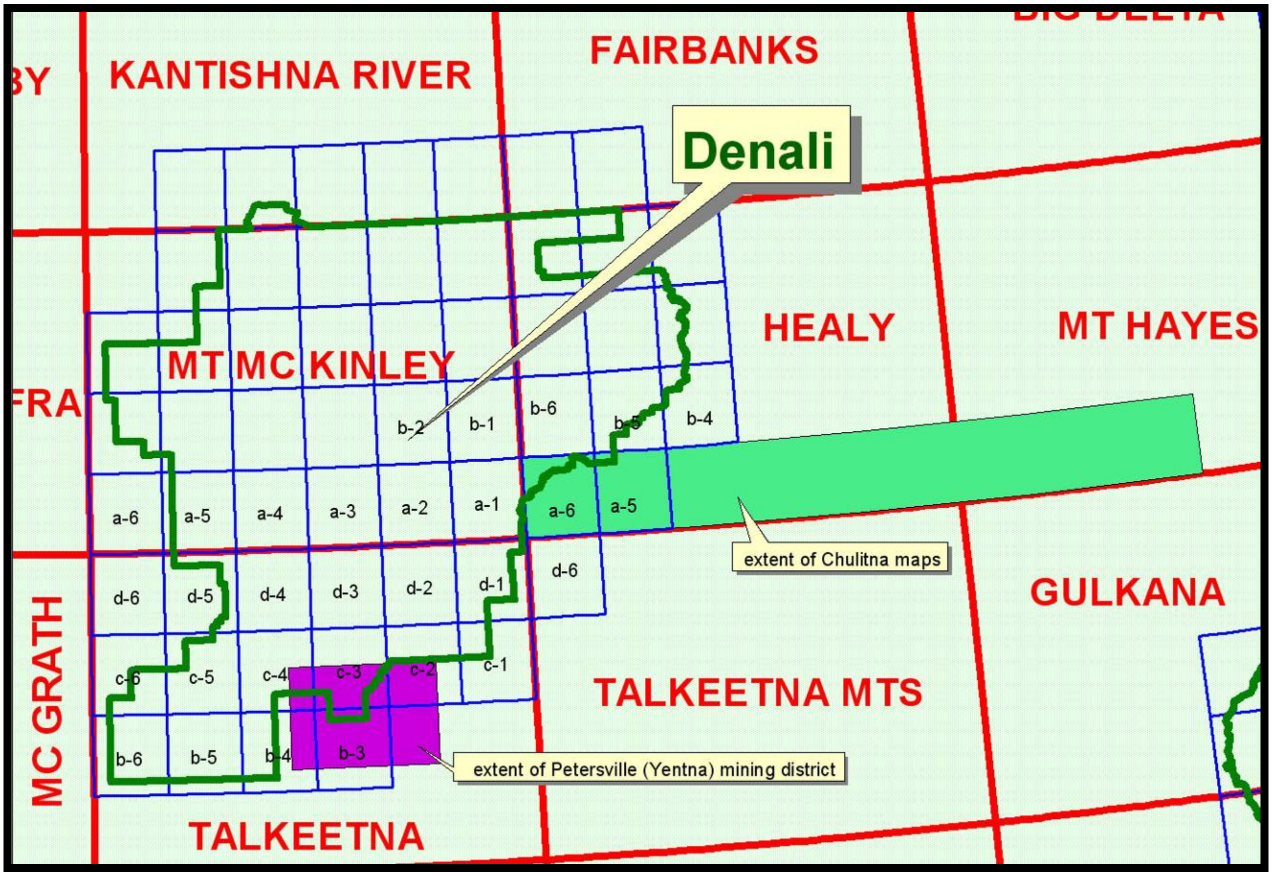

Figure 12. Extent of ADGGS maps of Chulitna region and Petersville (Yentna) mining district

For these maps, it is not known if they are already incorporated into the existing USGS OF-98-133-a or if they would be included in the newer proposed revisions of that publication.

UNPUBLISHED AND/OR INCOMPLETE GEOLOGIC MAPS

The USGS would like to periodically make updates to OF-98-133 as newer, more large-scale information is derived. Specific items they would like to update in a “version 1.2” would be to the McKinley, Healy, Talkeetna, and Talkeetna Mountains 250,000 sheets, as well as the Chulitna and Petersville areas.

<<need more for these:
currently unobtainable:
-request from Phil brease for interpretive map
- Jeanine’s Talkeetna transect
- 63,360 corridor high use coverage of the geology
- updated soils map from NRCS may be useful for surficial geology (125,000 scale) (draft at DENA already; hope to have by end of FY-2004)
McKinley Quadrangle (1:250,000) – hire Denali Associates (RIFed USGS geologists) to complete/publish the geologic map

Bibliography

- NatureBIB records, unknown what was captured, we should search on it
-Add to the bibliography:

- USGS publication by Wahrhaftig, Physiographic Provinces of Alaska
- -ahrhaftig, Central Alaska Geology and Engineering Geology
- USGS, I-1961, Healy Quadrangle interpretive pamphlet
- Colliers, Geology (introduction is good)
- Gilbert, Wyatt, Geology of Denali NP
- Reed, Geology of Mt. McKinley Quadrangle
- park fact sheets – topically or area specific
- GSA guide book (has appeared in a variety of sponsored formats)
    - Road log
    - Includes specific articles by different workers
    - Stratigraphic column
- Davis, Neil, "Permafrost"
- USGS fact sheet on the Denali quake
- GSA DNAG volume covering Alaska

-Park effort to include mining, tectonic, glaciers, etc. in Procite database (can provide to GRD for report)

-Robert Blodgett (USGS) is developing state-wide Paleontologic bibliography, can be found at http://www.alaskafossil.org

Geologic Features and Processes

The discussion of geologic features and processes was prioritized by the meeting participants. The prioritized list presented below reflects the level of importance of each topic relative to the other topics in the list and is based on: 1). its importance to resource management in the park, or 2). the need to obtain additional information about the specific geologic feature or process.

Permafrost Features and Processes

One very important geologic feature in the park is the presence of discontinuous permafrost, which can be found up to 2,000 feet below the surface. It consists of soil and rock that have been at a temperature of 32°F or colder for 2 or more years. A delicate heat balance exists between permafrost and the "active layer" above it. Changes in the vegetative mat, snow, or other characteristics of the upper layer can significantly alter the thermal regime, with resultant changes at ground level. This can cause melting of permafrost. In addition, an increase in solifluction, or soil movement, is possible. These phenomena can cause heaving, sagging, soil slumping, and erosion at the surface during successive periods of freeze-thaw in the active layer. The result can be detrimental to buried cables, utility poles, paved surfaces, and roadbed foundations. The term "thermokarst" describes a landform developed when permafrost is partially or totally melted. Thermokarst is highly irregular and forms variously shaped polygonal depressions. Thermokarst has been created in other parts of Alaska due to construction projects.

- Permafrost covers entire north side of park, bounded by Alaska Range, and a few spots in the south
- Features:
    - thermally unstable feature – Yedima
    - patterned ground – alteplanation (long smooth flat ridges)
    - thermokarst features are abundant (polygons and ice wedges)
    - Periglaciers

- Solifluction
- Major controlling factor on surface water and therefore vegetation (high ecological importance)
- Resource Management Issues / Concerns:
    - Impacts: thermokarst affects roads (roadbed foundations and other paved surfaces), buried cables and utility lines, buildings, and other developments, and poses problems for the disposal of liquid and solid waste.
    - Five major areas of park roads have been affected, issue on proposed north side access, southernmost extent of continuous permafrost.
    - Hillslope stability, limited areas of management concern (health and human safety issue)
    - Permafrost is very sensitive to human disturbance
- Inventorying / Monitoring:
    - Soil temperature monitoring set up, NRCS soil mapping, can create a derivative map from soils map of different types of permafrost (2800 sample sites for new soil map)
    - Road corridor monitoring, thermister installed 35 m deep
    - Inclinometer, piezometer locations along slopes by road
- Contact:
    - Guy Adema – DENA (907) 683-6356

Glacial Features and Processes

Four periods of glaciation are recognized in the Denali region. On the north side of the Alaska Range beyond the existing glaciers, moraine and outwash deposits extend into the foothills belt and cover large areas of bedrock. Except for some of the valleys, the foothills section was never glaciated.

- Glaciers cover 1 million acres or 1/6 of the park, there are approximately 400 glaciers that range in elevation from 1,000' – 20,000', 40 glaciers are named
- Kahiltna Glacier, is 44 miles long and is the longest glacier in the park and the Alaska Range, other named glaciers include the Ruth, Eldridge, Tokositna, Yentna, and the Muldrow Glaciers
- Most of the glaciers are consistently thinning, 25% of glaciers are surging (periods of slow flow, followed by periods of catch up) north side and west end
- Mostly valley or hanging glaciers in the park, unique because terminal areas insulated by their own debris, stagnate for longer periods of time
- Micro climates produced from large ice bodies, local cell moves moisture up, creating localized weather systems
- Features: cirques; horns; arête ridges; lateral, medial and terminal moraines; outwash plains; rock glaciers; lacunas; kettles; eskers; drumlins; U-shaped valleys; pro-glacial Lake Moody
- Cultural Associations: limited cultural work has been done on newly exposed areas from glacier retreat; don't have the snowpacks (dryer climate) that are found in WRST
- Resource Management Issues / Concerns:
    - Due to relief and rock lithology, DENA has many areas prone to erosion, huge unstable walls, glaciers grind up anything beneath them
    - greater visitation on glacial terminal areas, may ultimately present resource management issue (public health and safety)
    - Inventory / Monitoring:
    - monitor terminal positions
    - inventory named glaciers; would like to look at 1957 and 1983 photography/topographic maps to evaluate changes (as per WRST)
    - glacier profiling (part of larger state effort) 8 or 9 profiles in DENA, 3 are being monitored for climate change, another for surge monitoring, opportunistic longitudinal surveys are done depending on helicopter access
- Contact:
    - -Guy Adema – DENA, (907) 683-6356

Fluvial Features and Processes

- There are about 400 stream/rivers in the park, most are aggrading
- Foraker, McKinley, Kantishna, Toklat, and Teklanika Rivers originate on the north side of the park; while on the south side are the Yentna, Kahiltna, and Chulitna Rivers. The Nenana River forms the eastern boundary of the park.
- Classic braided streams (both glacial and nonglacial), placer mining has significantly altered streams in the park
- Non glacial streams – significant biological issue
- Unique hydrology on north side of park (shallow glacial lakes, very wet area)
- Resource Management Issues / Concerns:
    - safety for backcountry users, infrastructure
    - visitor and staff concerns for flooding
    - private lands (Kantishna) lodges, concern on floodplain
    - Inventory / Monitoring
    - -monitoring stream morphology at one site from gravel mining (administrative use), also monitoring bridges at stream crossings
    - -USGS WRD in Fairbanks active in this area
    - -DENA is funded this year for Water Resources Management Plan (Don Weeks, WRD) + Ken Karle (former DENA employee)
- Contact:
    - -Ken Karle

Seismic Features and Processes

- Numerous faults in the park - Denali fault system includes a number of subsidiary faults, fault scarps evident in the park
- 600 seismic events per year, most quite small, but periodically there is a large earthquake (e.g., 2002), most of these earthquakes (about 70%) have magnitudes that average between 1.5 and 2.5, and often occur near the surface (0-9 miles deep) at locations throughout the park
- November 3, 2002, the park (and most of central and southern Alaska) experienced a 7.9 magnitude earthquake; the epicenter was located approximately 30 miles east of the park on the Denali Fault, most of the damage was east of the park (~100 miles). The Denali Fault extends for 1300 miles from the Yukon border down to the Aleutian Peninsula.
- Mount McKinley uplift is at a rate of 1 mm/year (based on fission track dating)
- Resource Management Issues / Concerns:
    - damage to infrastructure, mostly outside of the park
- Inventory / Monitoring:
    - seismic activity receives a lot of attention in AK, studied by universities and USGS
    - park collaborates with Alaska Earthquake Information Center (AEIC)
    - Geophysical Institute at University of Alaska, Fairbanks (UAF) has 3 seismometers in the park (@ Wickersham Dome in the Kantishna Hills, Thorofare Mountain near the Eielson Visitor Center; and a repeater without seismic equipment was on Mount Healy).
    - USGS looking at aseismic zone west of 2002 earthquake - 100 mile gap, no volcanoes, seismically quiet zone
    - George Plafker in Menlo Park, CA heads USGS' effort, led work on 1964 quake
    - need new geode for state

Paleontological Resources

- Invertebrates primarily, marine mollusks, some insects, significant trace fossils, burrows (12 different types)
- Mostly Lower Cretaceous and older; since the Cretaceous, Alaska has been in its current location, ANIA, DENA, YUCH, WRST BIBE – rocks of same age, essentially represents paleo-ecosystem,

huge sequence exposed, can see time-variations of climate, park gets high enough in sequence to get K/T boundary, can see high latitude effects of K/T impact

- Robert Blodgett interested in invertebrates for *Paleogeography of Alaska*

Myrospirifer Breasei brachiopod was named after Phil Brease, only fossil in NPS named after a park geologist

Inventory / Monitoring:

-Using the Geoscientist in the Parks program, MS Access paleontological database produced, 200+ sites entered, need GPS for all sites (some locations are in GIS, need to refine descriptions; ground truth sites), Sara Schlichtholtz U. of MT was first GIP working on project, 240 Kenston, Geneva, IL 60134, email: Schlichtholtz@mc.net

-little has been published on DENA paleontology, long stretch of road in park can be surveyed, easily accessible

-most of paleontology work has been done on the Healy Quadrangle

-need more research on KT boundary, palynology is used to define ages

-substantial work needed, paleontology can answer terrane issue in park (or at least increase understanding)

-opportunity for interpretation at learning/science center

Unique Geologic Features

McKinley – granitic pluton (highest on Earth?), 18,000' of vertical relief (most relief on Earth?)

Braided rivers

Ruth Gorge – deepest gorge in North America

Denali fault – 1,300 miles long

Frozen ground features

Rotting glaciers – large bodies of ice stagnate and rarely move, on the surface are potholes (lacuna features), found in Alaska range

Travertine deposit – possible active geothermal area (need to confirm)

Altiplanation ridges - textbook examples

Surging glaciers – most in Alaska Range

Ancient glacial lake deposits (Lake Moody)

Lakes and ponds (2nd largest accumulation of any park unit?)

Volcanic Features and Processes

Ancient volcanoes

Two volcanic events; 56, 38 million years ago, one is equivalent in age with the formation of Mt. McKinley, suggests source of volcanic material was to the southwest,

rhyolites give color to Polychrome Pass (56 million years ago)

More recent volcanic activity near Eilson Visitor Center (38 million years ago), conspicuous from visitor center, good interpretive opportunity

Geothermal Features and Processes

- Have "cool" hot springs, need water chemistry on the south side of the park (Windy Creek) area
- Possible travertine deposits
- Wigane Creek – upwelling "cool" hot springs, is it geothermal
- Need hot springs inventory

Aeolian Features and Processes

- Significant loess deposits
- Dunes – north of park, also some near Foraker River area, not active dune field

Cave and Karst Features and Processes

- Devonian and Silurian ages - clean limestone units may have caves
- Contact:
  - Ron Kerbo – NPS-GRD, (303) 969-2097

Lacustrine Features and Processes

Lots and lots of lakes, puddles, and ponds
20% of park (NW of McKinley quad) area is a flat, boggy tundra where lakes, ponds and wetlands are the dominant features
Wonder Lake is 268 feet deep and is the largest kettle lake in the park, Chilchukabena Lake is located near the NW boundary of the park
Lake Moody – pro-glacial lake
surface ice on lakes, significant ecosystem driver
Water quality, bio contamination (airborne transport of pollutants) issues
DENA is seeking funds for lake study

Hillslope Features and Processes

- Resource Management Issues / Concerns:
  - engineering along Lake Moody
  - erosion along entrance road—landslides occur after rains
  - volcanic and sedimentary slope stability after rains, volcanics weather rapidly to clays
  - areas of subsurface sliding along road—repeated instability in places, reinforcement of slopes
  - rock glaciers
  - snow and ice avalanches—glacier landings, visitor use
  - cross glacier landslides—often triggered by earthquakes

Mining and Disturbed Lands

- Most of the past mining activity has been located in the Kantishna Hills (Yukon-Tanana terrain in the northern foothills region) and in the Dunkle Mine area (Chulitna terrain of the Alaska Range).
- Mining includes: base and precious metals (gold, lead, silver, antimony, zinc, and copper), coal, and in-park gravel mining for park roads
- Currently there are 28 patented claims and 86 unpatented claims (patented/unpatented data from GRD mining database 12/03)
- According to the GRD's 2001 AML database, there are 25 mine sites in need of reclamation in the park.
- Abandoned cabins, debris, small tailing piles, adits (mostly closed or collapsed) from hard rock mines
- Impacts: disturbed floodplains from placer mining, hazardous materials, water contamination — heavy metals, sulfides, petroleum drums, mercury in streams, tailings-concentrated metals because tailings weather faster than in situ rock,
  - Weiler's mining claims are a CERCLA site
  - Stampede – antimony mine, owned jointly with UAF (?)
  - Red Top mill (may be CERCLA site—we don't own the mill yet)
  - Kantishna—wholly within the park
  - Chulitna and Dutch Hills
- Lots of clean up efforts, revegetation, reestablishment of floodplains and streams
- Interpretive opportunities — mining history
- Contacts:
  - Dave Steensen – NPS-GRD (disturbed lands restoration) (303) 969-2014

Geologic Education/Outreach/Interpretation

Park needs fact sheets & web development assistance
South side nature center—state would like to map that quad, but can't map on federal land
Geology/geomorphology story may be moved to Eilson from headquarters VC
Park is requesting that GRD fund Ron Karpilo to continue glacier work at DENA, it was very helpful at GLBA

The following responses to the education/outreach/interpretation questionnaire were prepared by Phil Brease and address the interpretive needs of Denali National Park and Preserve staff and visitors:

What are the primary and secondary interpretive themes in your park?
If narrowed to just two, I would have to say, 1) tectonics – mountain building, and 2) alpine-piedmont glaciation.

What geologic topics are included in these interpretive themes and how are they being interpreted:

- -Geologic Features (volcanic edifices, ice age landforms, natural arches, etc.)
  1, 2, 3, 4, & 10 (moderate on text & visuals…weak on human delivery)
- -Geologic Processes (active volcanism, glaciation, coastal, fluvial, erosion, etc.)
  1, 2, 3, 4, & 10 (moderate on text & visuals…weak on human delivery)
- -Geologic Issues (mining, abandoned mines, cave management, geohazards, etc.)
  1, 2, 3, 4, & 10 (weak on both text-visuals & human delivery)

How is each geologic topic being interpreted (mark number next to each topic):
0 - Not interpreted in park.
1 - Wayside exhibits
2 - Museum exhibits
3 - Free publications (site bulletins, park newspapers)
4 - Sales publications (brochures, park geology books)
5 - Personnel services (walks, talks)
6 - Audio visual programs (films, video tapes)
7 - Trail guide/self-guided trail
8 - Jr. Ranger/Jr. Geologist program
9 - Educational Outreach program
10 - WWW Homepage
11 – Other

What other geologic features, processes, or issues are in your park that you are not currently interpreting?

- faulting, both past and current,
- seismicity & earthquakes,
- soils & permafrost,
- paleontology features,
- paleo depositional environments,
- many others…

How would you rate your geologic interpretive program:

- 4-5 (Geo interpreters in Denali are rare to non-existent. Most who work here are not that interested or have the geologic background to understand & appreciate the subject matter).

1 - Excellent
2 - Good
3 - Adequate
4 - Needs Improvement

5 - No current program

Are there active "partnerships" or other programs to interpret geologic resources in your park? (yes/no) If yes, what are they?

- The Geophysical Institute (University of Alaska) provides speakers related to the seismographs in the park. At each season start-up, they come out to Eielson visitor's center to talk to a few interpreters about Denali seismicity. Other geo-science researchers occasionally give talks to park staff or the public.

Do you currently have adequate stratigraphic columns and/or diagrams explaining your park's most important geologic topics? (yes/no/they are available but are inadequate)

- Probably the most complete, up-to-date stratigraphic column is one that I assembled nearly 15 years ago, and a copy can be found in chapter 34 of "Geology of National Parks" 6th edition, Harris, Tuttle & Tuttle, Kendall/Hunt publishing, 2004. I would hope it is as adequate as we can expect at this time.

Do you now have or do you plan to develop a curriculum based (school) educational program that deals with geologic resources?

____ Have a geology EE program
_X__ Developing or planning a geology EE program
____ No geology EE program
Currently I am making efforts to develop a teachers training curriculum for the Geology of Denali for a course this summer through the Denali Institute (www.denaliinstitute.org). Additionally, other geo-educational opportunities are expected to be developed as the Murie Science and Learning Center is completed and operational in the near future.

What are the obstacles to the interpretation of geology in the NPS? Please rank each issue 0 - 5 (0 = no obstacle; 5 = maximum obstacle):

_2__ Lack of available geology information.
_3__ Lack of visitor interest.
_5__ Lack of basic geologic background among interpretive staff.
_2__ Lack of communication between resource management/research and interpretation.
_3__ Lack of communication between geoscientists and interpretation.
_0__ No geoscientists on park staffs.
_4__ Difficulty/complexity of subject.
_4__ Lack of interpretation funding/staffing.
____ Other. Specify:

In your opinion, what measures should be taken to improve geologic interpretation in the NPS?

- (just what you & we are doing…..stronger presence of geoscience & geoscientists)

What would you like to see the GRD do to promote geologic interpretation? Rank each type of assistance needed 0 - 5 (0 = not needed; 5 = needed the most):

__3_ Obtain geologic research.
__0_ Summarize scientific findings.
__4_ Locate geoscientists to fill vacancies or VIP positions.
__3_ Provide technical assistance for geology publications or programs.
__4_ Develop partnerships between parks and geoscientists or geoscience organizations.
__3_ Develop Web site geology information.
__3_ Assist in development of lesson plans/activities for educational outreach programs and/or Jr Ranger.
__1_ Help obtain slides of geologic features and/or geologic samples for park interpretive collections.
__1_ Assist in development of training for interpretive staff.

__2_ Clarify NPS policy/regulations on geologic/paleontologic research/use.
__2_ Advise on geohazards.
__4_ Assist with obtaining funding (grants, etc.) for geologic interpretation.
____ Other. Specify:

Additional Comments:

The answers given above are based on the Denali situation where the geologic knowledge base is in a pioneer condition compared to most of the lower 48 parks. A very large part of the problem I see in advancing geologic information – interpretation at Denali, is the lack of interest (and funding) in completing the bedrock mapping and providing better park-wide maps, guides, or other publications. It seems that Denali should be on the forefront of major NPS units (such as Grand Canyon, Yosemite, Yellowstone, etc.) where basic geologic maps, if not a specific park-wide geologic map, is available. There is no single, conclusive map or document that tells the geologic story of Denali National Park. The interpreter or visitor must be a researcher to wind their way through various maps and documents of large areas, wide vintages, and evolving positions, to assemble the geologic picture of Denali. Although the geologic story at Denali is complex, the complexities are compounded by the lack of good summary publications.

On the positive side of NPS geosciences, Denali has more than most parks regarding geoscience staff. We have a geologist (myself), a glaciologist (who is also a geologist), a hydrologist (although currently a vacant position) and three technicians in air quality, climate and sound. As such, our needs are more in the basic support arena. We are very under funded for most physical science programs, particularly in the area of "inventory" where we can know & understand the natural physical science conditions in the park. If we don't know what we have, we will have great difficulty interpreting it to park staff and visitors.

We need better communication and cooperation between the NPS and other earth-science groups like USGS. Our geologic data and mapping needs have been well-known to the local (and perhaps Washington level) USGS, but their people and programs are continually cut or allowed to wither away. The "bio" has taken over "geo" in the Alaskan office of USGS and we have no other alternatives for unified geologic mapping, and other geologic data collection as we know it.

Park Contact Information

Park Name: Denali National Park and Preserve
Address: P.O. Box 9, Denali Park, AK 99755
Superintendent: Paul Anderson (907) 683-9581
Assistant Superintendent Resources Science and Learning: Philip Hooge, (907) 683-9627
Chief of Interpretation: Blanca Stransky (907) 683-9576
GIS Contact: Jon Paynter (907) 683-9571
Geoscientist (list discipline(s)): Phil Brease (907) 683-9551; Guy Adema (glaciologist), (907) 683-6356

Yukon Charley Rivers National Preserve

Executive Summary

During the Geologic Resources Evaluation scoping meeting, National Park Service park and regional staff identified the following geologic digital mapping needs and key resources management issues/needs:

Geologic Mapping:

1. YUCH staff desire a park-wide digital geologic map at least at 1:250,000 scale, much like exists for DENA and WRST; the Circle and Big Delta sheets are already completed, but only cover a small portion of the park (6 of 34 1:63,360 scale quadrangles), leaving digitization / revision / completion of the Charley River and Eagle 1x2 degree sheets as the obstacle to completing the park map
2. The Charley River 1x2 degree sheet (1:250,000 scale) was published as UGSG i-573 in paper format only, and needs major revisions to be incorporated into the existing DOGMAP
3. The Eagle 1x2 degree sheet was published as USGS I-922 in paper format only, but the Eagle and Charley River boundaries don't match well and need much reconciliation between them. Currently, Florence Weber is working on a revised surficial map of the entire Eagle sheet that the USGS plans to digitize
4. The ADGGS has published a series of 5 publications with maps for the Charley C-1, C-2, and part of the B-1, Eagle A-1, A-2 @ 1:63,360 scale (bedrock and surficial geology)
5. the USGS and Canadian Geological Survey (CGS) are working on a joint Yukon Territory map with an unknown publication date, but there are numerous map unit discrepancies associated with the international boundary that still need to be resolved

Geologic Resource Management:

Caves – associations with cultural resources
Dating volcanic ash - tephrachronology
Paleontology – lack of park specific information
Mineral development – claims, mining history, potential oil and gas operations in park
Permafrost
Fluvial – Yukon and Charley Rivers are key components of the park.

Introduction

Yukon-Charley National Monument was created by Presidential Proclamation on December 1, 1978. December 2, 1980 the 2,527,000 acre monument was redesignated as Yukon-Charley Rivers National Preserve by section 201 (10)(a) of the Alaska National Interest Lands Conservation Act (ANILCA) (94 Stat. 2371; 16 USC 3101; Public Law 96-487) to:

> *To maintain the environmental integrity of the entire Charley River basin, including streams, lakes and other natural features, in its undeveloped natural condition for public benefit and scientific study; to protect habitat for, and populations of, fish and wildlife, including but not limited to the peregrine falcons and other raptorial birds, caribou, moose, Dall sheep, grizzly bears, and wolves; and in a manner consistent with the foregoing, to protect and interpret historical sites and events associated with the gold rush on the Yukon River and the geological and paleontological history and cultural prehistory of the area.*

Geologic Overview

Geologically, the Yukon Charley Rivers National Preserve is significant because it contains:

A world-significant assemblage of diverse geological and paleontological resources that are unusually complete, providing at least a 600 million year record stretching back to the close of the Precambrian era.

The area between the Nation, Kandik, and Yukon rivers is postulated to be a portion of the North American plate that has escaped deformation from geological forces and remains as an intact geological and paleontological record. Some of the oldest known microfossils in existence have been found in this area.

The entire Charley River watershed is protected in its undeveloped natural condition and is classified as a “national wild river”.

The Yukon River is the largest natural, free-flowing river in the National Park System.

Sites preserving activities and events of regional significance associated with the gold rush era are present and exemplified by bucket dredges, mail trails, trapper’s cabins, boats, roadhouses, water ditches, and machinery.

The Preserve is divided into 2 distinct geologic areas by the Tintina Fault. The Tintina Fault is a strike-slip fault that runs parallel to the Yukon River corridor six to twelve miles south of the river. This fault is one of the great fault systems in western North America, extending 600 miles from northeastern British Columbia into Alaska.

Northeast of the Tintina Fault, the greatest bedrock diversity occurs in a triangle formed by the Nation and Yukon Rivers and the Canadian border. This triangular area is the only portion of east-central Alaska thought to be part of the original North American plate and it comprises a sequence of unmetamorphosed sediments (Precambrian, Cambrian, Ordovician, Silurian, Devonian, and Mississippian periods). These sedimentary rocks were once part of a continental margin and contain an outstanding record of marine faunal evolution that includes ammonites, trilobites, brachiopods, and corals. The oldest known microfossils from northwestern North America are also found in this triangular area.

The area southwest of the Tintina Fault is a sequence of complex igneous, metamorphic, sedimentary and volcanic rocks. These were probably metamorphosed and reformed when several small plates collided to form Alaska during the Cretaceous period.

Millions of years ago two crustal plates shifted along the Tintina Fault and caused superheated water to carry readily soluble minerals, including gold and silica toward the surface. As the water cooled a myriad of fractures formed in the fault zone and silica precipitated out to form quartz. Impurities such as gold trapped in the quartz concentrated in the fractures. The gold eroded from the veins and through time was deposited in the streams. Placer mining was used since the Klondike Gold Rush to mine the gold found at YUCH.

YUCH Geologic Mapping

The existing USGS OF-133-a contains digital geologic maps for two of the four 1x2 degree sheets of interest for YUCH (Circle and Big Delta sheets). However, most of the park's quadrangles of interest occur on the Charley River and Eagle sheets. At a larger scale, YUCH has (36) 1:63,360 scale quadrangles of interest; of these USGS OF-98-133-a covers only 6 of these 34 quadrangles of interest.

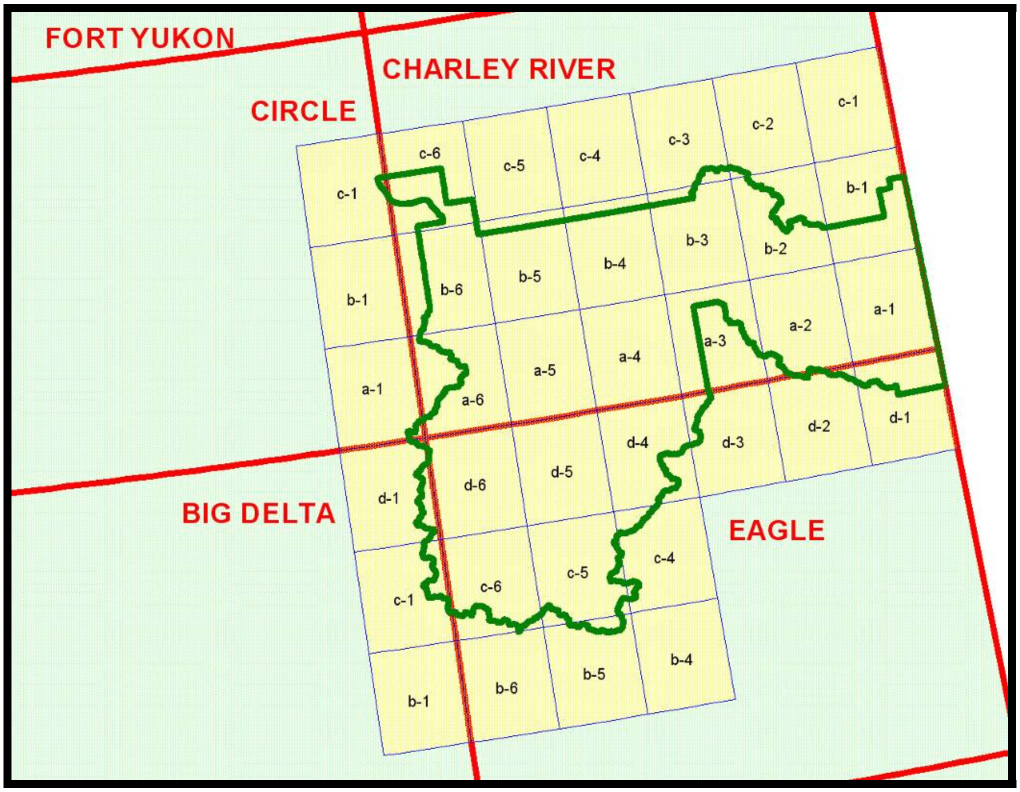

Figure 13. YUCH quadrangles of interest; 1:250,000 scale (red outline) and 1:63,360 scale (blue outline)

Other Published small-scale geologic maps

The Circle and Big Delta 1x2 degree sheets are published digitally in USGS OF-133-a, and GRE staff have a copy of this data that needs to be incorporated into the NPS-GRE model. Also, the Eagle (*Foster, H.L., 1976, Geologic map of the Eagle quadrangle, Alaska, U.S. Geological Survey, I-922, 1:250000 scale*) and Charley River (*Brabb, E.E. and Churkin, Michael, 1969, Geologic map of the Charley River quadrangle, east-central Alaska, U.S. Geological Survey, Miscellaneous Geologic Investigations Map I-573, 1:250000 scale*) 1x2 degree sheets have been published as "I-maps" by the USGS. Ric Wilson mentioned that the USGS has digitized each of those sheets as well, but have not "officially released" them, but they are willing to share these "preliminary" files with the NPS under the condition that the data only be used "in-house" until further notice from the USGS. Of importance however is that Ric also noted that he thought that each sheet needs major field revisions from his point of view. It was suggested that perhaps either Florence Weber or Jim Mortensen might be able to reconcile some of the discrepancies with these existing maps

The Alaska Division of Geological and Geophysical Surveys have also published the following for the Kandik area:

- *Van Kooten, G.K., Watts, A.B., Coogan, James, Mount, V.S., Swenson, R.F., Daggett, P.H., Clough, J.G., Roberts, C.T., Bergman, S.C., 1997, Geologic investigations of the Kandik area, Alaska, and adjacent Yukon Territory, Canada: Alaska Division of Geological & Geophysical Surveys, Report of Investigation 96-6A, 3 sheets, scale 1:200,000.*

- *Van Kooten, G.K., Watts, A.B., Coogan, James, Mount, V.S., Swenson, R.F., Daggett, P.H., Clough, J.G., Roberts, C.T., Bergman, S.C., 1997, Station locations in the Kandik area, Alaska, and adjacent Yukon Territory, Canada: Alaska Division of Geological & Geophysical Surveys, Report of Investigation 96-6B, 1 sheet, scale 1:125,000.*

- *Van Kooten, G.K., Watts, A.B., Coogan, James, Mount, V.S., Swenson, R.F., Daggett, P.H., Clough, J.G., Roberts, C.T., Bergman, S.C., 1997, Gravity maps of the Kandik area, Alaska, and adjacent Yukon Territory, Canada: Alaska Division of Geological & Geophysical Surveys, Report of Investigation 96-6C, 1 sheet, scale 1:250,000.*

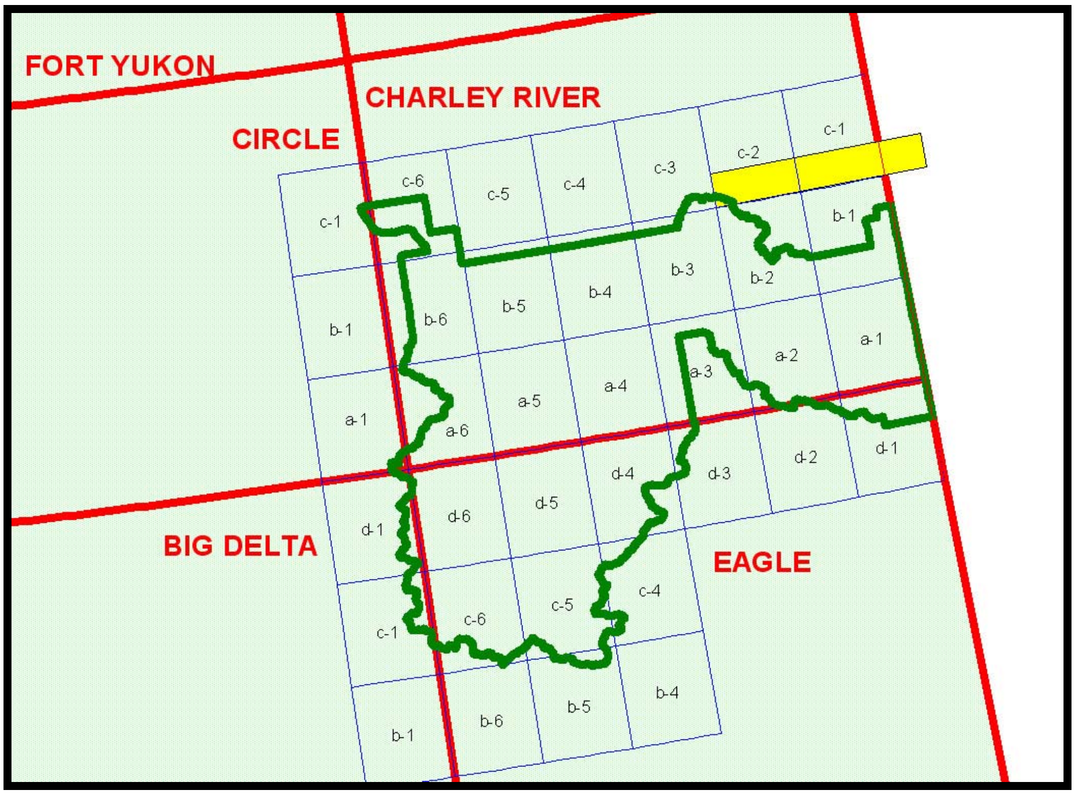

Figure 14. Extent of ADGGS RI-96-6 for the Kandik area (in yellow)

It is also thought that there is at least a "reconnaissance" level soil map available from the NRCS, but Pete Biggam should be contacted for more specifics.

Unpublished small-scale geologic maps

Ric Wilson mentioned that Florence Weber is developing a dedicated "surficial" geologic map that will supersede the earlier mapped surficial deposits presented in USGS I-922 for the Eagle 1x2 degree sheet. It is not known when this will be available or published at this time. The USGS does plan to digitize this map.

Ric Wilson also brought a paper copy of the *Geologic Map of the Upper Yukon River Basin* (a joint USGS-Canadian GS map), which is currently unpublished. Ric mentioned that the NPS could obtain the US portion of the map that is part of "DOGMAP" from the USGS as "preliminary" data, but that we would likely need to contact the Canadian GS to obtain the Canadian Yukon Territory piece. Ric said that we should contact Charley Roots in Whitehorse for the digital version of the Canadian portion. NPS-GRE staff will follow up on this matter. Ric thought the map did contain errors at the international boundary, and that it did NOT include an adequate treatment of the surficial geology.

Published Large-scale geologic maps

Currently there are a few known published larger scale geologic maps in the YUCH area. The Alaska Division of Geological & Geophysical Surveys has published recent material for the Charley River d-1, c-1 and parts of the b-1 quadrangles in the Public Data File series 95-33a, b, c, and d as follows:

- *Clough, J.G., Reifenstuhl, R.R., Mull, C.G., Pinney, D.S., Laird, G.M., and Liss, S.A., 1995, Geologic Map of the Charley River D-1, C-1, and part of the B-1 Quadrangles, East central Alaska:, Alaska Division of Geological & Geophysical Surveys, Public Data File 95-33A, 9 pages, 3 sheets, 1:100,000 scale*

- *Clough, J.G., Mull, C.G., Reifenstuhl, R.R., Liss, S.A., Laird, G.M., and Pinney, D.S., 1995, Interpretive bedrock geologic map of the Charley River D-1, C-1, and part of the B-1 Quadrangles, eastcentral Alaska:, Alaska Division of Geological & Geophysical Surveys, Public Data File 95-33B, 2 sheets, 1:63,360 scale*

- *Pinney, D.S., Clough, J.G., and Liss, S.A., 1995, Surficial geologic map of the Charley River D-1, C-1, and part of the B-1 Quadrangles, eastcentral Alaska:, Alaska Division of Geological & Geophysical Surveys (1972-present), Public Data File 95- 33C, 1:63,360 scale*

- *Pinney, D.S., Clough, J.G., Reifenstuhl, R.R., and Liss, S.A., 1995, Derivative geologic materials map of the Charley River D-1, C-1, and part of the B-1 Quadrangles, eastcentral Alaska:, Alaska Division of Geological & Geophysical Surveys, Public Data File 95-33D, 2 sheets, 1:63,360 scale.*

- *Pinney, D.S., Clough, J.G., Reifenstuhl, R.R., and Liss, S.A., 1995, Geologic Hazards map of the Charley River D-1, C-1, and part of the B-1 Quadrangles, eastcentral Alaska:, Alaska Division of Geological & Geophysical Surveys, Public Data File 95-33E, 2 sheets, 1:63,360 scale.*

These publications are all available for download from their website (http://www.dggs.dnr.state.ak.us/pubs/pubs?reqtype=quadrangle&ID=51&quadname=Charley%20River) as both PDF documents (text of report) and SID files (for maps). Tim Connors has talked to Fred Sturman at the ADGGS about the digital GIS files that comprise the SID's and has just received a CD-ROM and is in the process of evaluating them for incorporation into the NPS-GRE Digital geologic map model. These will then be evaluated by GRE staff and converted into the NPS-GRE model for digital geologic maps.

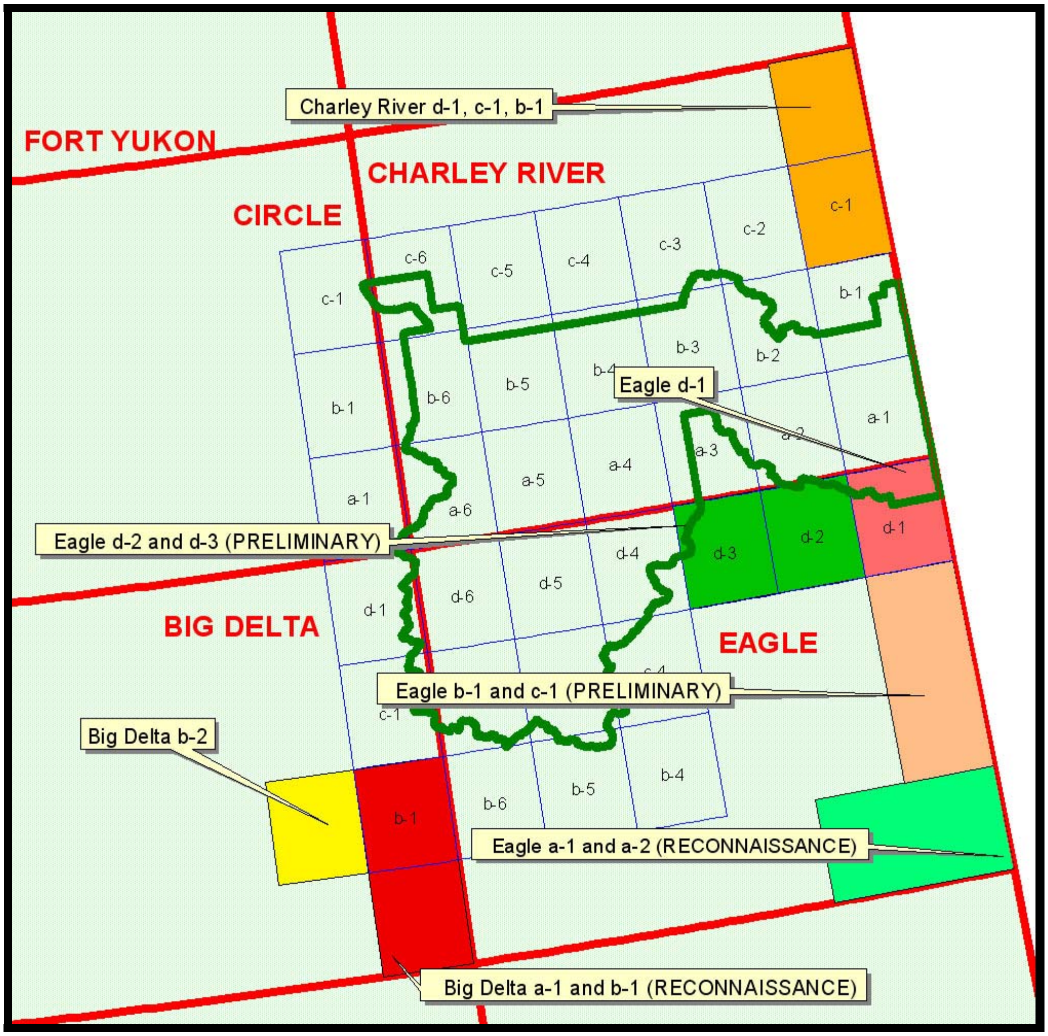

Figure 15. Large-scale published geologic mapping in YUCH area of variable vintage and detail.

Additionally, the USGS has published miscellaneous quadrangles within the Charley River, Eagle and Big Delta sheets since the 1960's. Some have been digitized, and mapping is of variable vintage and detail (preliminary, reconnaissance, etc.). The following is a list of those known quadrangles:

- *Brabb, E.E. and Churkin, Micheal, 1965, Preliminary geologic map of the Eagle D-1 quadrangle, east central Alaska, U.S. Geological Survey, OF-65-20, 1:63360 scale*

- *Clark, H.B. and Foster, H.L., 1969, Preliminary geologic map of the Eagle D-2 and D-3 quadrangles, Alaska, U.S. Geological Survey, OF-69-43, 1:63360 scale*

- *Foster, H.L. and Keith, T.C., 1968, Preliminary geologic map of the Eagle B-1 and C-1 quadrangles, Alaska, U.S. Geological Survey, OF-68-103, 1:63360 scale*

- *Foster, H.L., 1969, Reconnaissance geology of the Eagle A-1 and A-2 quadrangles, Alaska, U.S. Geological Survey, Bulletin 1271-G, 1:63360 scale. Scoping meeting participants indicated that digital versions of this map were available, and even though it isn't within the quadrangles of interest, YUCH staff are interested in incorporating this data into a master YUCH digital geologic database.*

- *Day, W.C., Aleinikoff, J.N., Roberts, Paul, Smith, Moira, Gamble, B.M., Henning, M.W., Gough, L.P., and Morath, L.C., 2003, Geologic map of the Big Delta B-2 quadrangle, east-central Alaska, U.S. Geological Survey, i-2788, 1:63360 scale*

- *Weber, F.R., Foster, H.L., Keith, T.E.C., and Cantelow, A.L., 1975, Reconnaissance geologic map of the Big Delta A-1 and B-1 quadrangles, Alaska, U.S. Geological Survey, MF-676, 1:63360 scale*

Bibliography

- -Add GSA DNAG Alaska volume to bibliography
- -Robert Blodgett (USGS) is developing state-wide Paleontologic bibliography, can be found at http://www.alaskafossil.org

Geologic Features and Processes

The discussion of geologic features and processes was prioritized by the meeting participants. The prioritized list presented below reflects the level of importance of each topic relative to the other topics in the list and is based on: 1). its importance to resource management in the park, or 2). the need to obtain additional information about the specific geologic feature or process.

Cave and Karst Features and Processes

Some large caves identified in the Preserve, anecdotal information of cave and overhang sites
Old USGS notes, Blodgett shared information, can provide more
Possible paleontological and ecological significance
Paleozoic (Devonian?) age carbonates
More of interest in caves from natural/cultural resource perspective than there is a concern over visitor use - eastern end of Berringia corridor – major migration path for humans and animals
Need inventory of caves and their contents
Contacts:

- Ron Kerbo – NPS-GRD, (303) 969-2097

Fluvial Features and Processes

- The Yukon River traverses the Preserve from east to west for approximately 160 miles of the river's total 1800 mile length.
- The 106 mile long Charley River empties into the Yukon River, the entire 1.1 million acre Charley River watershed lies entirely encompassed within the Preserve. Classified as a National Wild River.
- Other major rivers in the Preserve include: Tatonduk, Nation and Kandik Rivers
- Historical discharge data from USGS gauging for 8 years, pulled station, too expensive
- Previously, significant contamination from mining, has been cleaned up
- Resource Management Issues / Concerns:
    - Geologic reconstruction of Pleistocene history (outburst floods, temporary re-routing of rivers)
    - Navigability of Nation, Kandik, Charley Rivers still being discussed
    - Remove tailings; put river back in historic stream channel
    - Shoreline impacts stemming from big boat engines
    - Sediment loads and impacts on fisheries

Paleontological Resources

- The rocks in the park record an almost unbroken succession the history of the area covering 800 million years ago to about 40 million years ago.
- Ogilvie Mountains – westernmost remnant of North American craton (covering Precambrian, Cambrian, Ordovician, Silurian, Devonian, and Mississippian periods), most complete assemblage of North American microfossils, rocks were once part of a continental margin and contain an outstanding record of marine faunal evolution that includes ammonites, trilobites, brachiopods, and corals.
- -Cambrian Trilobites – concern about erosion removing fossils, remote locations, fish-like organisms
- -coral reefs – Early Devonian
- -McCann Hill chert – early to late Devonian important fossil bearing formation
- -Devonian exposures – evolution of jaws; life moves onto land (Nation River exposures with fossil fish remains), better exposed since fire swept through the park
- -Permian Takhandit Limestone – USGS pro paper describing western NA brachiopods
- Abundant Pleistocene bluffs exposed, palynological evidence
- A lot of work done along river, repeat visits to specific sites, Charley River exposures add to Cretaceous reconstruction
- Resource Management Issues / Concerns:
- -most useful paleontological products: survey paleontological resources and add to Blodgett dataset, develop exhibits, use data for site protection

Permafrost Features and Processes

- Ice rich permafrost present
- Unique vegetative assemblages, suspect geologic basis
- Features: large pingo (NOTE: Pingos form when water moves up under the root mat, and freezes. When water freezes it expands, pushing up the soil. Pingos can be as small as one foot high (one third of a meter) or over 35 feet high (over 10 meters).
- Resource Management Issues / Concerns:
  - -blow out lakes, as permafrost melts, lakes drain into river
  - -if ice poor permafrost fails – affects surface water
  - -if ice rich permafrost fails – large depressions develop
  - -road maintenance problems
- Contact:
  - Guy Adema DENA, (907) 683-6356

Mining and Disturbed Lands

The streams on the south side of the Yukon River are the source of placer deposited gold in the park. Creeks such as Coal Creek, Woodchopper Creek, Ben Creek, Sam Creek and Fourth of July Creek all supported gold mining efforts in the early- to mid-twentieth centuries. Mining was done by hand until the 1930s when dredging began in the park. Mining occurred as recently as 1977 when operations ceased at the Coal Creek Dredge.

Currently there are 15 patented claims and 113 unpatented claims (patented/unpatented data from GRD mining database 12/03), Woodchopper Creek area has most of park's patented claims

According to the GRD's AML database, there are 6 mine sites in need of reclamation in the park.

Current mining have filed Plan of Operations

Joe Vogler claims operated, potential for significant operations given price of gold. Following Vogler's murder in 1993, the claims are now controlled by the Vogler Estate.

Bucket dredges, mail trails, trapper's cabins, boats, roadhouses, water ditches, and machinery, dredge tailings - park is mapping historical resources and have adaptively reused mining structures for park use.

Mining is significant cultural resource, may increase visitation, or more tourism on river itself

Massive coal seams (caught fire in the past few years)

fee simple oil and gas in NE side of park are privately owned, access through rivers. NOTE: The USGS Energy Assessment team will be doing an energy (oil and gas)assessment of the Yukon Flats area which includes the park. The assessment should be completed during the latter part of 2004.
Coal Creek historic mining district (NRHP listed)
4th of July Creek, has been cleaned up
Inventory of cultural sites through fire related work
Contacts:

- -Dave Steensen – NPS-GRD (disturbed lands restoration) (303) 969-2014
- -Sid Covington (mining) (303) 969-2154

Volcanic Features and Processes

Tephra layers are the focus of collaborative research

- -markers for archeological and paleo (Holocene age)
- -derived from Wrangell volcanic activity
- -because of lack of glaciation, soil development more is more extensive than other areas in Alaska, can reconstruct "paleohistory"

Cultural and climate history (UAF research primarily from Quaternary research)
No active volcanism in the park

Seismic Features and Processes

- Tentina fault (Charley River area, trends NW-SE)
- Aseismic for long time
- Numerous subsidiary faults have been active

Unique Geologic Features

- Mineral licks - attract sheep and other wildlife
- Pingos
- Basement rocks of Alaska - unique plant assemblages
- Paleontological resources - cover long period of time
- Pleistocene bluffs - have relict artic steppe vegetation equivalent in age to when mammoths were present
- Incised meanders of the Charley River
- Ophiolite complex
- Calico Bluffs Formation – type section, Lower Pennsylvanian or upper Mississippian age
- Mining history/mineralization
- Charley River fold and thrust belt, includes everything north of Tintina fault

Geothermal Features and Processes

- Some hot springs may be present (found on old USGS field notes), location is unknown

Aeolian Features and Processes

- Significant loess deposits on Calico Bluffs along Yukon River
- Bluffs slough loess, see fresh exposures

Glacial Features and Processes

- Significance is that Wisconsin glaciation did not occur in the park
- Unglaciated terrain provided pathway for human and animal migrations, relict vegetation in park

Hillslope Features and Processes

- Resource Management Issues / Concerns:
    - Sloughs in river, along road – concern on water quality stemming from 1999 burn, little area in park not experiencing, fires exacerbate problem

Geologic Education/Outreach/Interpretation

Interpretive materials that the park is interested in obtaining include:

- Nature of Beringian vegetation during Pleistocene (need palynological information)
- Paleontology – fact sheets, posters, web pages
- Mining History (recent book publication)
- Tatondik River geologic interpretation

The following questionnaire, prepared by Pat Sanders, Park Ranger - Interpretation addresses the interpretive needs of Yukon Charley staff and visitors:

What are the primary and secondary interpretive themes in your park?
globally significant assemblage of diverse geological and paleontological resources,
entire 1.1 million acre Charley River watershed,
habitat for highest density nesting population of American Peregrine Falcons in North America,
portions of the Han Athabascan traditional homelands,
sites preserving evidence of Klondike Gold Rush era,
large areas that represent an unglaciated refuge for endemic floral and faunal communities.
Since primary interpretive themes are resource based, the use of those resources is a secondary theme, ie, subsistence activities, sport hunting, recreation, etc.

What geologic topics are included in these interpretive themes and how are they being interpreted:
-Geologic Features (volcanic edifices, ice age landforms, natural arches, etc) - 3, 4, 6, 9
-Geologic Processes (active volcanism, glaciation, coastal, fluvial, erosion, etc) - 3, 4, 6
-Geologic Issues (mining, abandoned mines, cave management, geohazards, etc) - 1, 2, 3, 4, 6, 10

How is each geologic topic being interpreted (mark number next to each topic):
0 - Not interpreted in park.
1 - Wayside exhibits
2 - Museum exhibits
3 - Free publications (site bulletins, park newspapers)
4 - Sales publications (brochures, park geology books)
5 - Personnel services (walks, talks)
6 - Audio visual programs (films, video tapes)
7 - Trail guide/self-guided trail
8 - Jr. Ranger/Jr. Geologist program
9 - Educational Outreach program
10 - WWW Homepage

What other geologic features, processes, or issues are in your park that you are not currently interpreting?
Tintina Fault, lack of glaciation

How would you rate your geologic interpretive program: - 4

1 - Excellent
2 - Good
3 - Adequate
4 - Needs Improvement
5 - No current program

Are there active "partnerships" or other programs to interpret geologic resources in your park? (yes/no) If yes, what are they? No

Do you currently have adequate stratigraphic columns and/or diagrams explaining your park's most important geologic topics? - they are available but are inadequate

Do you now have or do you plan to develop a curriculum based (school) educational program that deals with geologic resources?

____Have a geology EE program
____Developing or planning a geology EE program
__x_No geology EE program

What are the obstacles to the interpretation of geology in the NPS? Please rank each issue 0 - 5 (0 = no obstacle; 5 = maximum obstacle):

_3_ Lack of available geology information.
_0_ Lack of visitor interest.
_3_ Lack of basic geologic background among interpretive staff.
_4 Lack of communication between resource management/research and interpretation.
_4_ Lack of communication between geoscientists and interpretation.
_4 _No geoscientists on park staffs.
_2_ Difficulty/complexity of subject.
_5_ Lack of interpretation funding/staffing.
_4_ Other. Specify: Access

In your opinion, what measures should be taken to improve geologic interpretation in the NPS?

Geologists from regional offices offer training and/or input in preserve interp. Program

What would you like to see the GRD do to promote geologic interpretation? Rank each type of assistance needed (0 = not needed; 5 = needed the most):

__2_ Obtain geologic research.
__3 Summarize scientific findings.
__3_ Locate geoscientists to fill vacancies or VIP positions.
__4_ Provide technical assistance for geology publications or programs.
__3_ Develop partnerships between parks and geoscientists or geoscience organizations.
__2_ Develop Web site geology information.
__4_ Assist in development of lesson plans/activities for educational outreach programs and/or Jr Ranger.
__0_ Help obtain slides of geologic features and/or geologic samples for park interpretive collections.
__5_ Assist in development of training for interpretive staff.
__3_ Clarify NPS policy/regulations on geologic/paleoentologic research/use.
__2_ Advise on geohazards.
__3_ Assist with obtaining funding (grants, etc.) for geologic interpretation.

Park Contact Information

Park Name: Yukon Charley Rivers National Preserve
Address: Eagle River Station, P.O. Box 167, Eagle, AK 99738
Superintendent: Dave Mills
Chief of Resources: Thomas Liebscher (907) 455-0620
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GRE Scoping Meeting Attendees
CAKN - February 24-26, 2004

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